LAMK Lahden ammattikorkeakoulu
Lahti University of Applied Sciences

TOWARDS CIRCULAR ECONOMY

EU, Finland and Lahti Region Perspectives

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Katerina Medkova

Lahti University of Applied Sciences
Degree Programme in Environmental Technology

MEDKOVA, KATERINA:

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ABSTRACT

In nature, all systems are practically cyclical and waste-free, whereas our current economic system is linear, wasteful and too much based on an assumption of abundant and cheap resources. In fact, this unrelenting depletion is considered as causing the Earth's natural resources to go bankrupt. The linear fashion thinking ought to be revised and the ends of the straight imaginary line must be looped to form a continuous cycle, with no or a minimum produced waste.

The waste should be regarded as a potential resource for something new in the same way as Mother Nature works. It is time to think circular; it is time for a change. It is time for creative and innovative thinking. It is time for novelty, the new industrial revolution called the Circular Economy.

The philosophy of the circular economy can be described as: 'Today's products are reused, remanufactured or refurbished to be reborn as tomorrow's products'. To start with, we are required to remodify our values, attitude and mindsets.

This work describes the circular economy and advocates its purpose and benefits. It examines the drivers and enablers towards a new sustainable way of living and prosperity without compromising the economic growth. The most obvious obstacles and limitations of the concept's implementation are also unfolded. Moreover, case studies and real examples from the European Union, Finland and Lahti region are described.

Qualitative in-depth interviews revealed opinions and experiences of six professionals and the actions taken, as well as the future plans in Finland, regarding this global trending topic.

The research outcomes confirmed the need and the importance of raising awareness and understanding of a circular economy among the general public, in order to get people 'on board'. The major challenge facing the transition towards the circular economy is people's mindset as the principles are rather simple but the implications are vast.

Key words: circular economy, resource efficiency, material efficiency, industrial symbiosis, industrial ecology, blue economy

CONTENTS

We have only one planet Earth...

ABBREVIATIONS

DO- Developmental Orientation

EPA-Environmental Protection Agency

EPR-Extended Producer Responsibility

ESCO-Energy Saving Concept

FISS- Finnish Industrial Symbiosis System

FQ – Framing Question

GDP- Gross Domestic Product

GPP-Green Public Procurement

R&D-Research and Development

PAYT- Pay-As-You-Throw

PPP- Public-Private Partnership

REACH-Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals

ReSOLVE-ReGenerate, Share, Optimise, Loop, Virtualise, Exchange

ReSOLVER- ReGenerate, Share, Optimise, Loop, Virtualise, Exchange tool by McKinsey

RQ – Research Question

SaaS-Software as a Service

TGOS-Total Green Office Solution

TREC-Tyre Recycling

WWF-World Wildlife Fund

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1 INTRODUCTION

This chapter serves as an introduction to this study, outlining the background, objectives and scope of the study, as well as the three research questions that will be examined.

The current world population has exceeded seven billion. Such a number of people poses two to three times more than the sustainable level would be. The population is expected to grow to ten billion by the end of the century, yet the size of the planet Earth remains the same. (World Population Balance 2014.) As a consequence of a rapidly growing population, the demand for products and natural resources increases and, therefore, the gross domestic product (GDP) per capita as well (Towards the Circular Economy Vol 1 2012).

As an example, the giant speed of economic growth of China and India, the biggest countries by population, are described. It took China only 12 years to increase twofold its per-capita GDP. India needed 16 years to double its GDP. The United Kingdom achieved the same doubling of GDP in 154 years. (Towards the Circular Economy Vol 1 2012,19.)

Bill McKibben (2007, 18) stated" Even before we run out of oil, we're running out of planet." In reality, the world's resources would cover the needs of only two billion people at a European standard of living and about over one billion at American way of living. In general, humankind consumes about 50 % more resources than our planet can produce. If the people lived globally as an average American citizen, we would need more than five planets Earth to cover the needs. (World Population Balance 2014.)

The global natural resources will soon 'go bankrupt'. This will and already has an impact on the world's economy. Our economy of today is based on the principles where economic growth is conditional on increased resource exploitation in order to satisfy the need of the current growing population.

Even if the population decreased, which is not probable, and the use of resources diminished, it would still not be enough. Such a change would only extend the time of a coming collapse. Instead, a radical transformation of the present economic system and decoupling the growth from the resources is needed.

1.1 Background

Our current economy is linear-oriented, which is often referred to as a take-make-use-dispose model. The resources have been extracted at a constantly increasing pace since the Industrial Revolution. Then, the resources are turned into products that are disposed of at some time during their lifetime, not necessarily at their end of the life time. Most often products are replaced by new ones simply for a better look, better functions or just because we want to and we can.

There is a limited availability of resources and following this unsustainable approach, it leads, sooner or later, to complete depletion of raw materials. Already, we can see the increased prices of virgin raw materials, reflecting the limited accessibility and availability of resources, which causes the cost pressure for manufacturers to attain the basic input, the raw materials, for their production.

The idea that our planet has its limits, or thresholds, which are defined as 'planetary boundaries', are explored in a novel project, led by Johan Rockström (2009) from the Resilience Centre in Stockholm. Nine planetary boundaries were identified, as seen in Figure 1: climate change (1), ocean acidification (2), stratospheric ozone (3), biogeochemical nitrogen cycle and phosphorus (4) cycle, global freshwater use (5), land-system change (6), and the rate at which biological diversity (7) is lost, chemical pollution (8) and atmospheric aerosol (9) loading. For the last two boundaries (8, 9) the levels have not been determined yet. (Rockström et al 2009.)

If these boundaries are crossed by the human activities on the planet, it creates a risk of "abrupt or irreversible environmental changes", which can

make Earth less liveable (Rockström et al 2009, 2). The research concludes that in the long-term, the planet's capacity has been exceeded already in three key areas, such as biodiversity loss (1), the management of the nitrogen cycle (2) and climate change (3). (Rockström et al 2009)

The inner green nonagon, in Figure 1, symbolizes the operating space which is still safe. The red colour shows the estimation of the current state.

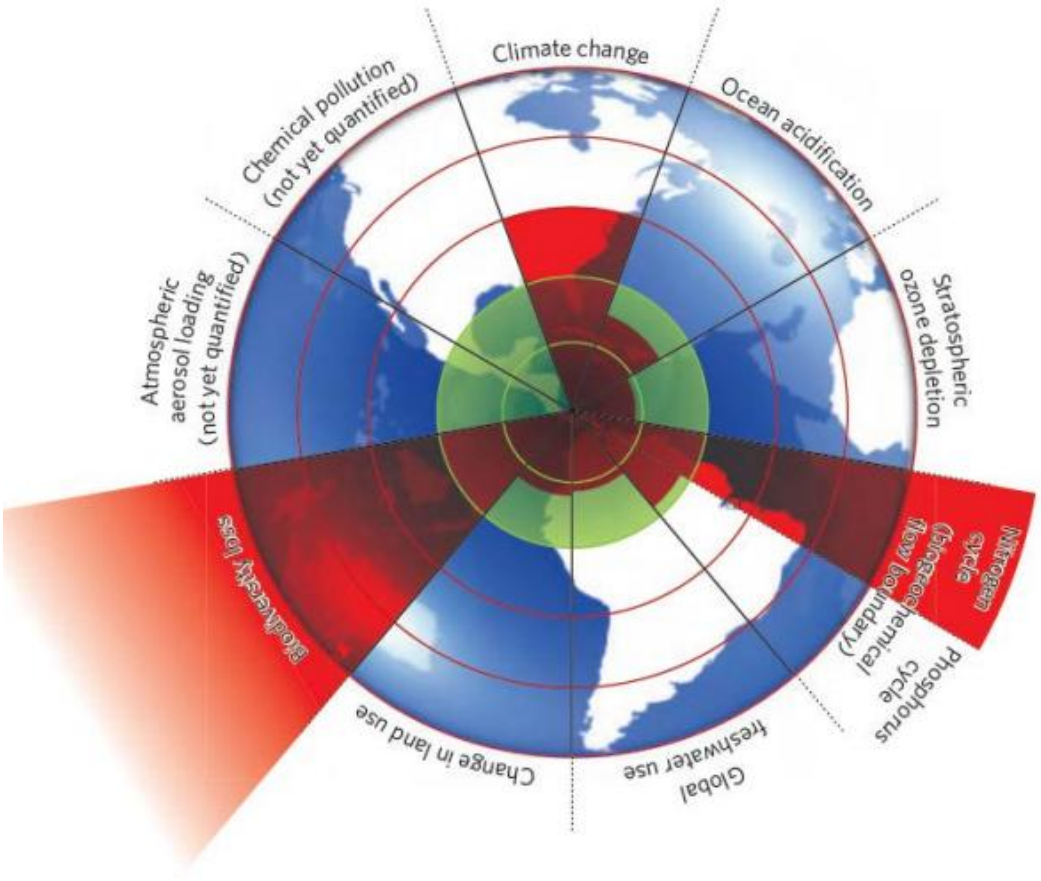

Figure 1. Estimate of quantitative evolution of control variables for seven planetary boundaries from preindustrial levels to the present (Rockström et al 2009).

In 2015, the 'planetary boundaries' research was updated and it was announced that four out of nine boundaries have already been crossed: climate change (1), loss of biosphere integrity (functional diversity and genetic diversity) (2), land-system change (3), and altered biogeochemical cycles (phosphorus and nitrogen) (4), as seen in Figure 2. (Steffen et al. 2015.)

In Figure 2, the green areas demonstrate safe space, the yellow areas show areas of uncertainty (increasing risk) and the red areas symbolize high-risk zones (Steffen et al. 2015).

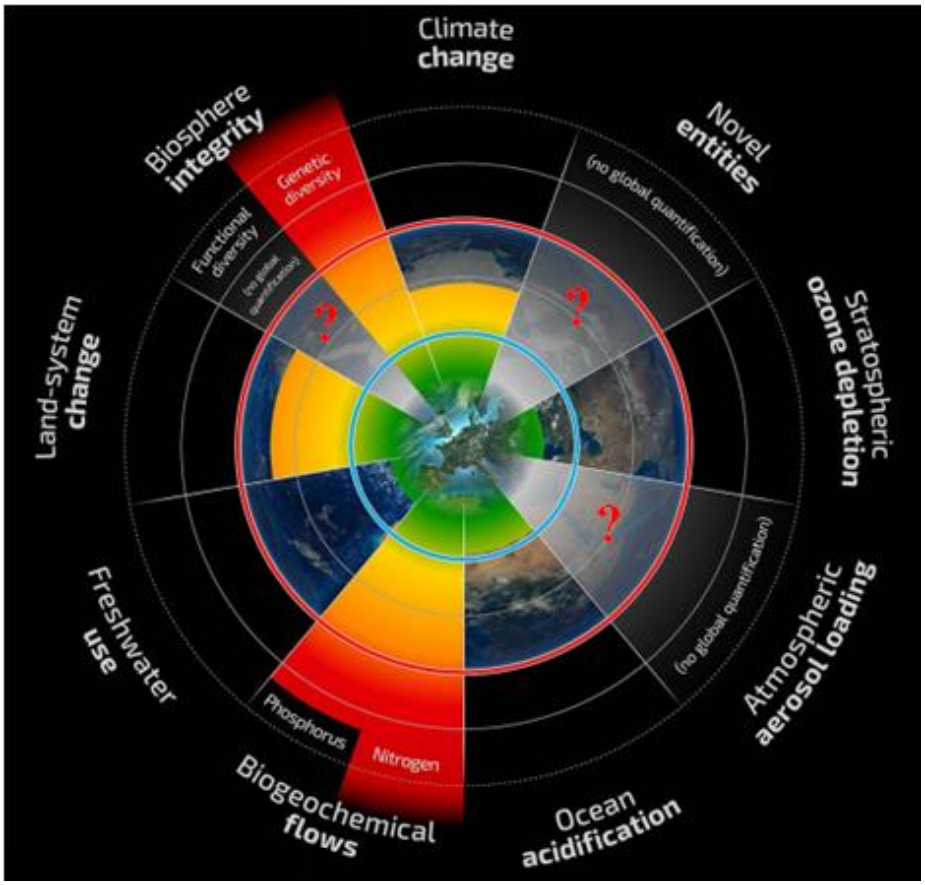

Figure 2. Planetary boundaries (according to Rockström *et al*. 2009 and Steffen *et al*. 2015).

A new economic system, which would function within the limits of our planet, is needed. A resilient waste-free system, which restores the ecosystem and, at the same time, it is practical for the environment, society and economy. A system called a circular economy.

1.2 Research Questions, Objectives and Scope

The framing question (FQ) was defined in order to answer the three research questions below. The framing question plays a central role in the research effort as it helps to build the background information and logic,

necessary for further research.

FQ: What is the concept of a circular economy?

Three research questions addressing the different aspects of the research topic were formulated:

1. **What are the challenges/obstacles for a circular economy development (a) in the European Union and (b) in Finland?**
2. **What are the circular economy drivers?**
3. **What are the enablers of a circular economy implementation?**

The research objective is to introduce the circular economy model, its potential stimulants and existing challenges. One of the goals is to present the circular economy philosophy with concrete examples and cases within the European Union, Finland and the Lahti region. Furthermore, the thesis strives to promote the circular economy concept and to acknowledge that the change is happening and also, to inspire the others. The research aims to raise the awareness of a concept of a circular economy, its principles and benefits to the environment and all inhabitants of the planet Earth.

The scope is that the research can be extended to all players involved in the model; companies, municipalities, governments, but most of all, the consumers and communities in general.

1.3 Limitations

The focus of the research is limited to the European Union and Finland in particular. Also, the consumers' and producers' points of view are excluded from the empirical part of the study.

The indicators and methods used for analyzing and assessing the progress of the transition towards a circular economy are out of the scope of this research.

1.4 Theoretical Framework

Primary and secondary data, such as academic books and articles dealing with circular economy and other studies served as a source of information. Also, the author participated in related seminars and courses, either in person or online. Moreover, in-depth interviews with professionals personally involved in activities connected to a circular economy are part of the framework.

1.5 Research Approach

This qualitative research approach can be divided into two equally important parts; (1) the literature review and (2) the in-depth interviews. The research overview is depicted in Figure 3 below.

The literature review, in other words the theoretical part of the research, forms the foundation for gathering the necessary background information needed for conducting the empirical part of the research. A qualitative method approach was selected for collecting the empirical data; more specifically, the in-depth interview tool was used. Altogether six interviews were conducted and will be discussed in detail in Chapters 3 and 4 of this thesis.

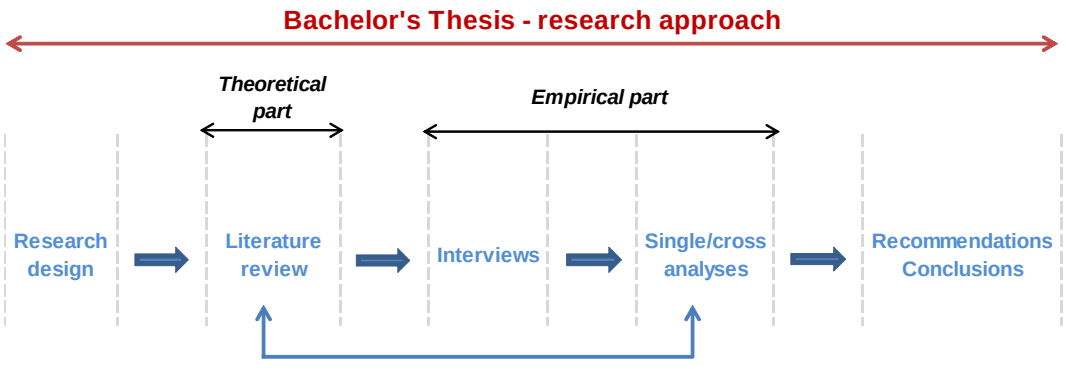

Figure 3. Research approach overview.

It became evident that the literature sources come mainly from the European Commission and Finnish governmental programmes, strategies and various related reports. Also, academic articles, several studies and books dealing with specific issues and topics were used, rather than books with a holistic and comprehensive view on a circular economy that are missing in the market.

The literature review included the historical development of a circular economy and the principles and philosophies it is based on. In order to present the all-embracing picture of this model, which is the umbrella of several schools of thought, it was necessary to filter out the relevant data and information. Reviewing the various sources of literature was also essential for creating the themes and questions for the interviews. Furthermore, it gave basis for partial answers to the research questions. These findings will then be compared with the responses collected during the interviews. The outcomes will be analysed and conclusions made.

2 CONCEPT OF CIRCULAR ECONOMY

The energy and material prices have been volatile and growing since 2001 due to continuous depletion of the Earth's natural resources. Another factor is the global population expansion. Only in the European Union, the population growth from 2010-2020 is estimated to increase by three percent, from 501 million to 514 million people (WRAP 2014). The current linear model has its limitation and cannot succeed in the long run anymore. A new model, which would reflect the needs of today's world, is required. The circular economy model offers a sustainable and resilient long-term solution that would close the resource loops and still bring prosperity and safety to the society and the environment. (Ellen MacArthur Foundation 2015.)

According to the 2012 Ellen MacArthur Foundation report, produced together with McKinsey, the circular economy model could save to European manufacturers US $630 billion a year by 2025. (Stahel 2012; Towards the Circular Economy 2012, 2013, 2014.)

A circular economy is the key element of this study; therefore, its meaning will be further explored. The historical development and what preceded the circular economy model will be examined. By examining the literature, various definitions and terminology were found. It is essential to present the basic definitions and introduce various perspectives and approaches, in order to understand the complexity of the circular economy concept.

2.1 Definitions and Principles

One distinctive way to describe a circular economy is the one quoted on Ellen MacArthur Foundation's website:

> *The circular economy refers to an industrial economy that is restorative by intention; aims to rely on renewable energy; minimise, tracks and eliminates the use of toxic chemicals; and eradicates waste through careful design(Ellen MacArthur Foundation 2015).*

The Commissioner Jyrki Katainen (2015) sees the move towards the circular economy as one of the key megatrends for sustainable future by stating:

> *It is a development I would compare with globalisation; it makes no sense fighting against it* (Closing the Loop 2015a).

The 2015 Ellen MacArthur Foundation & McKinsey report defines a circular economy as:

> *... an economy that provides multiple value-creation mechanisms which are decoupled from the consumption of finite resources (Growth Within: A Circular Economy Vision for a Competitive Europe 2015).*

The foundation of the above-mentioned definition is formed by three principles; (1) natural capital preservation and enhancement, (2) resource yields optimisation, and (3) system effectiveness management. Based on that, McKinsey identified six levers: ReGenerate, Share, Optimise, Loop, Virtualise and Exchange - together, the ReSOLVE framework. These levers are depicted and marked red in Figure 4. (Growth Within: A Circular Economy Vision for a Competitive Europe 2015.)

All these six levers, the ReSOLVERs, represent a business opportunity in a circular model. These levers complement and reinforce the impact of each other. The ReSOLVERs descriptions follow below.

- ReGenerate
    - Use of renewable energy and materials
    - Reclaim, retain and regenerate ecosystems
    - Recovery of biological resources and their return to biosphere

- Share
    - Low speed in loops

    - Maximisation of products utilisation by sharing (peer-to-peer or private sharing) and products reuse – second-hand
    - Lifetime prolongment by maintenance, repair and durable design

- Optimise
    - Products' efficiency/performance increase
    - Lean philosophy – minimize waste formation in production and throughout the supply chain

- Loop
    - Components and materials to be kept in closed loops
    - Inner loops preferences
    - Finite materials – to be remanufactured; recycling considered as a last option
    - Renewable materials – anaerobic digestion and extraction of bio-chemicals from biological waste

- Virtualise
    - Virtual utilities – online books, shopping, offices

- Exchange
    - Old materials to be replaced with advanced non-renewable materials
    - New advanced technologies to be applied (3D printing)
    - New products and services to be used (Multimodal transport)

(Growth Within: A Circular Economy Vision for a Competitive Europe 2015)

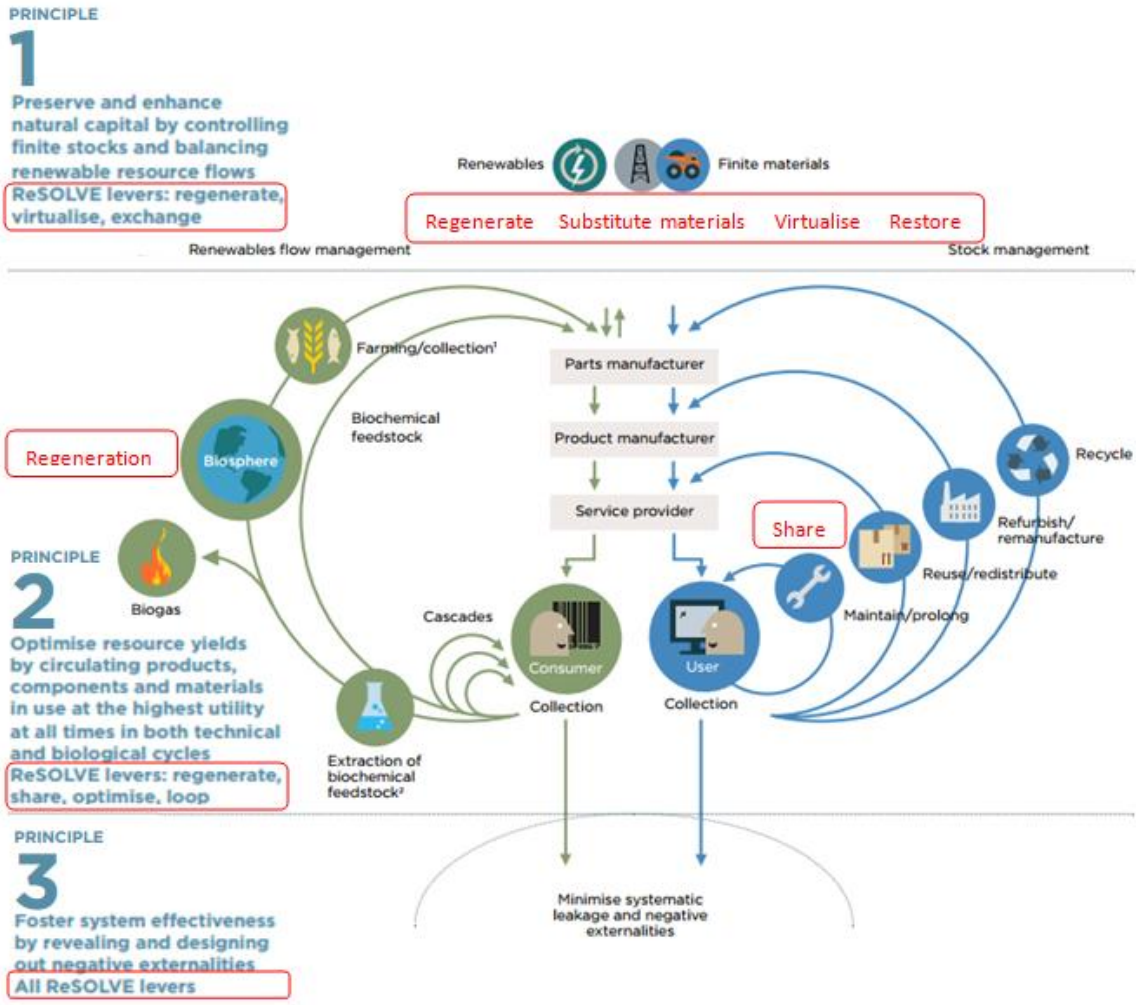

Figure 4. Circular economy principles and levers (Growth Within: A Circular Economy Vision for a Competitive Europe 2015, 24).

Stahel defines the central notion of a circular economy as the value of quantity and quality over the added value; therefore the operation and maintenance are pivotal capabilities in preserving the value – energy, emissions and water embodied in components. (Stahel 2013.)

Current economy follows the linear ‘take-make-use-dispose’ model depicted in the top part of Figure 5. Raw materials are extracted and transported for manufacturing and turned into products. Products are then transported to consumers, used, and later discarded and eventually replaced by a newer model, causing enormous material and energy waste.

The model is based on large amounts of easily accessible resources. (The Circular Model 2013.)

In order to improve the environment and thus our health and wealth, the ‘green economy’ has been promoted. The green economy is based on renewable energy, bio-food, and the use of biodegradable materials. Bioproducts have become a fashion, a symbol of health and a good intention. However, these products are usually affordable only for a small group of people, as their prices are too high. In actual fact, not all ‘green’ products are green. Most of them need to be transported long distances, so their carbon footprint is rather high. Also, some biodegradable ingredients are not grown sustainably, so their impact on the environment is rather debatable. For instance, the massive palm oil use in several industries during the recent years is not as environmentally friendly as it looks at first. Palm oil is biodegradable; however, the increased palm tree plantations are the detriment of the rain forest. According to Gunter Pauli (2010), also renewable energy coming from solar and wind power plants are heavy tax burdens as they are dependent on subsidies. A new system, smarter and effective, is needed; a system, which would enable to supply healthy food, products and services to the majority of people in an affordable way. (Pauli 2010.)

The green economy is connected with recycling. According to the Oxford Dictionaries, ‘to recycle’ is the process of converting (waste) into a material by reusing it again or by returning material to a prior stage in a cyclic process (Oxford Dictionaries 2015).

Recycling itself decreases the use of raw materials. All in all, it only slows done the natural resources’ collapse; it does not prevent it. Recovering raw materials from products by recycling only is not effective enough due to a high loss of value and energy; however, efficient recycling can be used for the transition period from the linear to the circular system. (Ellen MacArthur Foundation 2015.)

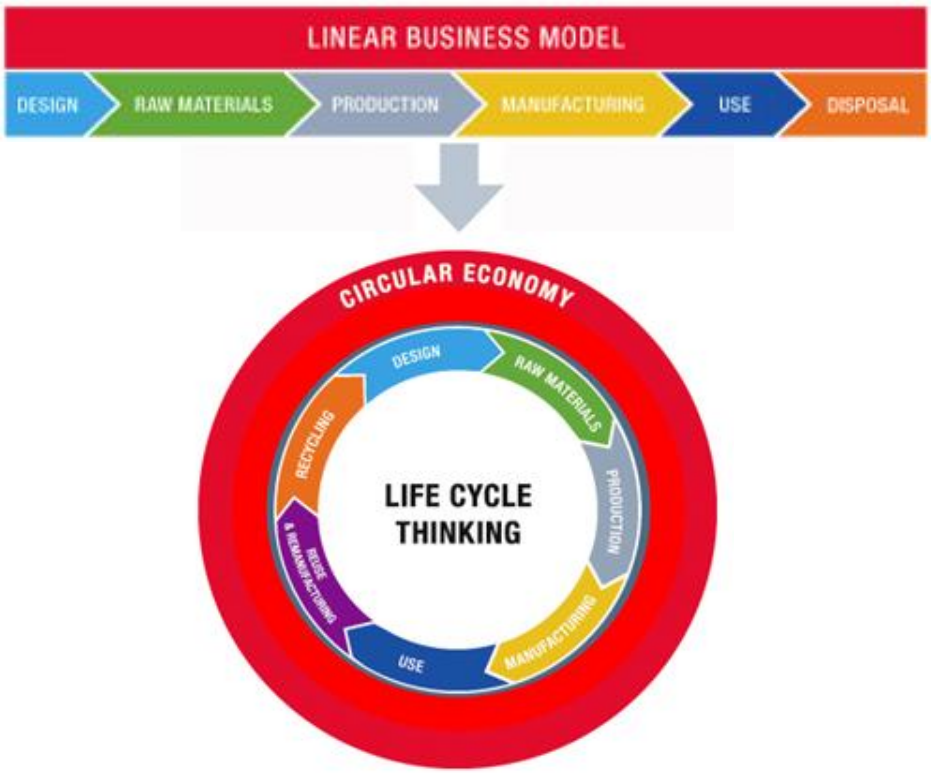

Figure 5. Linear vs. Circular business model (http://www.worldsteel.org/steel-by-topic/life-cycle-assessment/Life-cycle-thinking-in-the-circular-economy.html).

To think circular (Figure 5, at the bottom, and Figure 6) means to pay attention to the product design at first, so that products are easy to dismantle, rebuild or refurbish and thus easily reused or recycled if needed. Conditionally, the price of these 're-activities' needs to be competitive and, therefore, encouraging to abandon the current practices of buying a new product as the cheapest option.

In addition to the technical side (Figure 6), the biological side also needs to be addressed. It concerns not only food and food waste but also the biochemical feedstock that can be extracted from the food waste and to be used as a renewable resource, which can substitute certain chemicals (Kline 2015). It includes, for instance, the production of biofuels, renewable bioenergy, value-added biochemicals or plastics produced from renewable sugar sources of bio-feedstocks (Austin 2009).

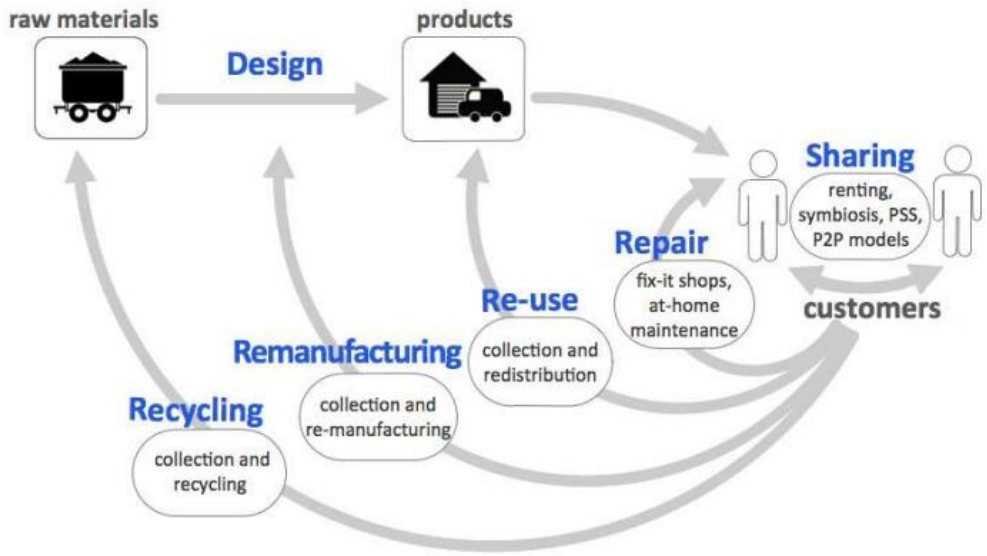

Figure 6. Technical cycle in a circular economy (www.innovationseeds.eu/ImagePub.aspx?id=242392).

In a circular economy model, a consumer becomes just a user, not necessarily the owner of the goods. The shift from ownership into a service-oriented world is the key. Customers seek for a quality service, which is provided by the use of a product. For instance, customers are interested in getting illumination; they do not necessarily want to purchase a bulb and a lamp. In the circular economy, the resources are allocated in an offered product or service, so its purpose and also the economic benefits are maximised. Then, the manufacturer turns into a service provider and there is an impetus to develop durable, long-lasting and easily repaired bulbs, in order to decrease their costs. At the same time, customers can benefit from high-quality products and services. The change in manufacturer thinking will boost the innovative and creative product design, producing products that could be repaired, reused, remanufactured or repurposed. It is not anymore about a quantity, it is about a quality, the quality that lasts. The same could be applied to vehicles. Most of the time cars are not in use. We do not need a car, we need to get from place X to place Y, and so we can ask for mileage purchase instead. (Rau 2013; Closing the Loop 2015a; Kline 2015.) In general, selling products as services lets the manufacturers preserve

resources embodied in the goods and subsequently secure the future own material (resource) supply (Stahel 2012, 2013).

The benefits of the circular economy are to: (1) secure the future resources, (2) to accelerate the regional employment of all qualification scales, and last but not least, (3) to increase the living system resilience and to reduce the greenhouse gas emissions, particularly CO_2 by using renewable energy. (Stahel 2012, 2013; Growth Within: A Circular Economy Vision for a Competitive Europe 2015.)

2.2 Circular Economy Goals

The model of a circular economy aims for decoupling the economic growth from natural resource constraints by involving the innovation, product, material and system designs, and a change towards a service-based economy. This way, the concept of ‘end of life’ products or materials will be eliminated and shifted towards the ‘restore-reuse-recycle’ concept. (Ellen MacArthur Foundation 2015; Victor & Jackson 2015.)

The circularity principles based on Ellen MacArthur Foundation are depicted in Figure 7 below. The model in Figure 6, presents the material flows organised into two types, (1) biological materials, marked in green and located on the left-hand side of the figure and (2) technical materials, marked in blue and situated on the right-hand side. (Zils 2014; Ellen MacArthur Foundation 2015.) The closed loops, with no starts and ends, are the foundation of the system (Stahel 2012).

The cycle of biological materials is designed in a way that enables the material to safely re-enter the biosphere. On the other hand, the aim of the technical materials cycle is to prevent hazardous substances from entering the biosphere and to extend the lifespan of products and materials by a redesign, reuse, remanufacturing and recycling. (Zils 2014; Ellen MacArthur Foundation 2015.)

The circular model brings the materials and components and the inside embedded capital back to the economy, so that it actually eradicates waste creation and thus erases the use of landfills and incineration plants. (Zils 2014; Ellen MacArthur Foundation 2015.)

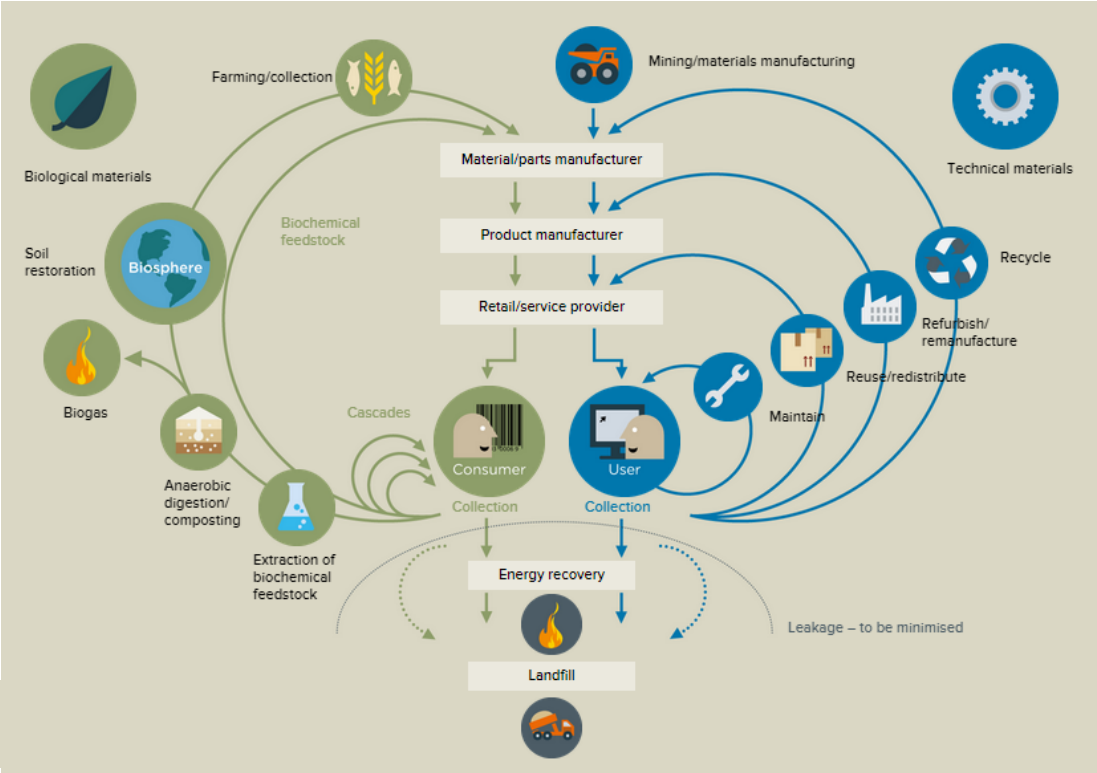

Figure 7. Outline of a circular economy (Ellen MacArthur Foundation 2015).

According to Stahel (2012) and Zils (2014), the smaller the loop is, in other words, the closer the loop is to the user/consumer (Figure 7), the more profitable and resource efficient it is as the higher value is preserved. Stahel (2012) stated: “Don’t repair what is not broken; don’t remanufacture what can be repaired; don’t recycle what can be remanufactured”. The closer-to-the-user/consumer loops (reuse, repair) are the most economical and resource beneficial if organised locally or regionally, as the double transportation costs can be avoided. At the same time, this supports the regional job market creation. On the other hand, the outer recycling loop is based on a globally located business, aiming to find the cheapest labour in the market. (Stahel 2012.)

A good example supporting the repair principle is, for example, an open source site iFixit, which guides people how to fix a wide range of products. It contains manuals, technical hints and shares knowledge. This site also offers links to e-shops to get tools and needed spare parts. (iFixit 2015) Another example from Vienna, Austria is the Centre for Repair and Services called R.U.S.Z. (Reparatur- und Service-Zentrum), which offers onsite repairs of bigger household appliances in the region. R.U.S.Z. also provides durable and upgraded second-hand appliances and electronic equipment with a warranty to their customers. Moreover, it creates job placements for long-term unemployed people, whom it trains into technicians. (R.U.S.Z. 2015.) Another example is the Repair Café concept, which started in Amsterdam, the Netherlands, in 2000. Since then, it has spread out across 18 countries and has reached over 800 Repair Cafés in total. Repair Café is a free meeting place, where people can come and repair things together with other skilful professionals and learn from them. People can come to have a cup of coffee or to help to repair others' goods. Repair Café helps to pass the valuable practical knowledge, connect people and extend the goods' life and thus contributes to the sustainable society and environment. More than 13,000 products are repaired every month. (Repair Café 2015.)

The final stage is recycling. Recycling, more accurately 'downcycling', is according to McDonough and Braungart (2002) only "stopping off en route (to landfill)". Recycling and manufacturing products from recycled materials, which were never designed for this purpose, are heavy on energy, often expensive and sometimes generate as much waste as when made from primary materials. (McDonough and Braungart 2002, 56.) Therefore, efficient and effective recycling demands smart product design, sophisticated waste separation, collection, sorting, and technologies enabling the processing of each waste stream (Kline 2015).

The waste hierarchy can be reflected in job creation potential as well. According to US Environmental Protection Agency (EPA) and Institute of

Local Self Reliance (2008), the job creation exponentially grows with the closer to the centre of the cycle the activity (loop) is.

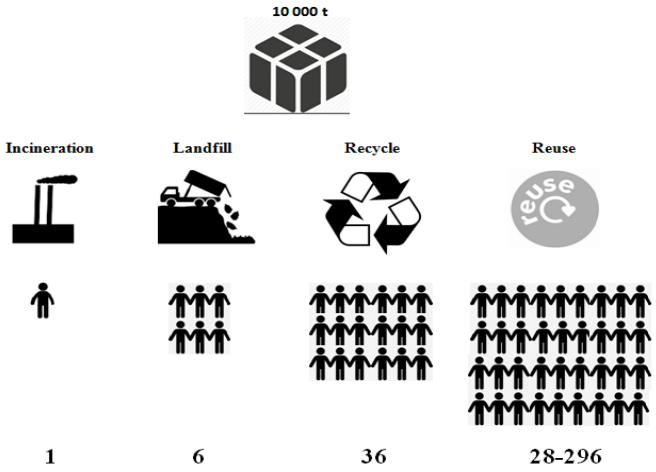

Figure 8. The impact of the waste hierarchy on job creation, based on Closing the Loop 2015a source.

As an example (see Figure 8), 10 000 tons of waste/material was used. If these 10 000 tons were landfilled, it would employ six people; in case of incineration, it would drop down to only one person. On the other hand, recycling would give a job to 36 people and when waste/material is reused, it is estimated that 28-296 jobs would be required, depending on the waste/material. (Closing the Loop 2015a)

2.3 History and Development

In what follows, the meaning of a circular economy, its historical development, and its current status will be outlined.

There is no one single date or author of the concept of a circular economy. However, it is assumed that its first roots came from the late 1970s when being discussed by a modest group of academics, innovators, and businessmen. (Ellen MacArthur Foundation 2013, 2015.)

A circular economy framework is based on several allied philosophies and principles, such as a regenerative design, performance economy, cradle to

cradle design philosophy, industrial ecology, and biomimicry (Ellen MacArthur Foundation 2013, 2015; Circle Economy 2015). All these schools aim for mimicking nature and the human beings integrating and living in symbiosis with the environment, rather than destroying it (Regenerative Leadership Institute 2015). As aptly described in McDonough and Braungart's book (2002)"Nature doesn't have a design problem. People do.".

2.3.1 Regenerative Design

The concept of Regenerative Design is based on a theory of process-oriented systems. 'To regenerate' means 'to recreate, renew, restore or revitalize', meaning no waste is formed. In other words, others' waste is used as an input in a closed loop model of input and output. Regenerative design goes beyond the sustainable design, the idea of which is based on creating something that lasts but not regenerates in anything new. The foundation to regenerative design was given by John T. Lyle, a US landscape architecture professor, in the late 1970s. (Ellen MacArthur Foundation 2013; Lyle Centre for Regenerative Studies 2015; Regenerative Leadership Institute 2015.)

2.3.2 Performance Economy

Walter R. Stahel, a Swiss architect, is regarded as the father of Performance Economy. The Performance Economy focuses on economic and quality utilisation and performance. It does not focus on manufacturing. The Performance Economy is based on creation of knowledge and wealth separated from resource consumption (Stahel 2010, 3). It aims for existing stock optimization and selling goods as services. The Performance Economy leads into a new product design approach, enabling an effective reuse of products' components. Such an approach would secure the material supply by maintaining the product ownership. Consequently, waste creation would be prevented. (Ellen MacArthur Foundation 2013; Stahel 2012, 2013.) The three goals of the

Performance Economy are wealth and job creation and reduced resource consumption. Stahel wrote about the Performance Economy (2010) that it 'shifts economic thinking from doing things right to doing the right things' (Stahel 2010, 5).

2.3.3 Cradle to Cradle® Design Philosophy

The term 'cradle to cradle' was first coined by Walter R. Stahel in the late 1970s. The Cradle to Cradle® design was developed by a German chemist, Michael Braungart, together with an American architect, Bill McDonough. It endeavours to improve product quality "by moving from simply being 'less bad', to becoming 'more good'" (McDonough Braungart Design Chemistry 2013). The concept regards all materials to be nutrients, either technical or biological, circulating in a healthy and safe system. This philosophy aims for integrating both effective and efficient products design with diminishing any negative impacts. Nature is a model for circulating material flow and thence the product components design works with continuous recovery and reuse principles, waste-free and a minimum energy and water utilization. (Ellen MacArthur Foundation 2013; McDonough Braungart Design Chemistry 2013.)

2.3.4 Industrial Ecology

Professor Roland Clift (2013) defines Industrial Ecology as a concept which considers material and energy stocks and flows in the economy. It aims for shifting from the current open-loop linear systems to the closed-loop systems, where a waste represents a material input for other processes. Industrial Ecology focuses on designing the production processes in a way in which the amount of materials in a product is minimized. It intensifies the product use, for instance, by sharing or prolonging the product's life. Besides that, it directs at extending service life by repairing or upgrading the discharged products. On top of that, thanks to smart product design, Industrial Ecology achieves easy component dismantling and reuse, and recycling as a last choice.

Sustainability issues are approached from multiple perspectives; ecology, economy, technology and also sociology. One of the Industrial Ecology's subsets is Industrial Symbiosis, focusing on material and energy exchange and even, knowledge, capacity, services and utility sharing among various companies. (Clift & Allwood 2011; Ellen MacArthur Foundation 2013, FISS 2015a.)

2.3.5 Biomimicry

Janine Benyus (2002) defines Biomimicry as "a new science that studies nature's best ideas and then imitates these designs and processes to solve human problems". Biomimicry considers nature as a thought-provoking model (1), a measure (2) for judging our innovations, and an inspiring mentor (3) we can learn from and modify our overall views and values, well expressed by Benyus (2002) as "doing it nature's way". (Benyus 2002, Ellen MacArthur Foundation 2013.)

2.3.6 Blue Economy

The position of the Blue Economy is unclear. It is believed it is incorporated in the generic concept of a circular economy as other previously mentioned schools of thought (Ellen MacArthur Foundation 2013; Circle Economy 2015; Holder 2015). Others, however, assume it moves the circular economy to a new level or dimension (Alexandru & Tasnadi 2014; Huxley 2015; Possible People 2015). The designer of the Blue Economy model itself, Gunter Pauli from Belgium, when asked by the author of the thesis in an email conversion, stated "Blue Economy goes much further than circular (economy)" (Medkova 2015). Pauli places the Blue Economy as a successor to a Green Economy. Pauli regards the Green Economy to be too expensive, not competitive, and available mainly to the wealthy. The prices of 'green products' are even threefolds, in comparison with ordinary products of the current 'red economy'. (Alexandru & Tasnadi 2014; Pauli 2015.) The Blue Economy goes "beyond mere preservation". First, it looks at widely and cheaply

accessible local sources/waste (inputs), which are of no or a little use and value for others, the same way as ecosystems do. Then, several key principles are applied, such as “Something...is replaced by...nothing” following the laws of physics. (Pauli 2010.)

The foundation of the Blue Economy business model lies on 21 principles, focusing on economic, environmental and social benefits by means of local resources (Ellen MacArthur Foundation 2013; Possible People 2015). As written by Pauli (2010, 69) “Ecosystems source everything locally”. One of the key principles supports the waste-free nature’s model of ‘cascading nutrients and energy’ (Pauli 2010, 68). The Blue Economy model prioritizes local entrepreneurship development, which ensures purchasing power to grow and, therefore, the local, regional and national capital increases as well. According to Pauli (2010, 28), “You will never hear of unemployed trees, fish, or mushrooms!”. The Blue Economy aims for developing multiple streams of revenues, local job creation and innovation inspired by nature. As a result, the environment is sustained and economic growth brings healthy society. (Alexandru & Tasnadi 2014; Ellen MacArthur Foundation 2013; Possible People 2015; Pauli 2010, 2015.)

Besides all these above mentioned principles, also non-technical activities are needed in order to close the loop, such as service inclusiveness, mental shift in sharing and renting, rather than owning goods, and co-operation (Greyson 2015).

2.4 Drivers towards Circular Economy

Several global drivers exist, causing the need for shifting from the current linear model towards the circularity. First of all, it is the scarcity of natural resources (1), their volatile and constantly rising prices and accessibility. Secondly, it is the increasing demand (2) caused by the global population growth and increased buying power of middle-class consumers. Thirdly, it is the desire for strong domestic employment (3). It is also the shift of consumers’ behaviour (4) from ownership towards service oriented

generation of customers with a preference of using products and goods, rather than owning them. There is a certain shift in socio-demographics (5) including the urbanisation growth and thus reduction of the collection costs. Moreover, the rising use of emerging technologies (6) connects more and more people and, at the same time, provides information of products and materials and, therefore, offers high traceability throughout the supply chain. Also, it is companies' need for longer-term investments (7) in material price and risk sustainability in order to secure their competitiveness and existence. And last, the boom of legislation and regulation use (8) with regards to Earth sustainability plays a role too. (Ellen MacArthur Foundation 2015.)

Furthermore, the circular economy is not solely about material and resource efficiency, it embraces the whole economy by considering other business models, reverse logistics (Aftermarket customer service), the use of renewable energy, and also product and systems design (Ellen MacArthur Foundation 2015).

2.5 Challenges, Barriers and Proposals

According to Jeroen Gillabel, one of the challenges is how to assure the secondary raw material costs to be lower and the quality to be better or at the same level as the primary resources. In some cases, such as in the case of some plastics, the state-of-the-art technology makes the recycling material financially unattractive. The investments in technology and innovation, such as Horizon 2020 Programme or other financial instruments can unblock the barrier. Cooperation and information sharing can speed up the transition. And then, these findings should be shared. For instance, the green tax policy could bridge the price gap between the virgin and secondary materials. (Closing the Loop 2015a, Roadmap - Circular Economy Strategy 2015.)

Disharmonized legislation in the member states across the value chain, not binding targets and missing quality standards, together with a lack of

reliable information, represent the barriers of the European resource market development today. For instance, the targets should include not only recycling targets, but also targets for repair and refurbishment or recycle content requirements in products, to cover the whole chain. Also, the supply-demand of the secondary markets needs to be managed. The splitted understanding and distortion of the product and by-product status within the EU complicates its cross-border transportation and brings an administrative burden, as commented by Dirk Vanderberhe. This is caused by the linear legislation approach and it is especially visible with regards to chemicals (REACH). This is the reason for designing regulations to fit better the new circular model, where all elements of the value-chain will be included and, at the same time, the sector-specific regulations need to be taken into account as well. (Closing the Loop 2015a, Roadmap - Circular Economy Strategy 2015.)

One of the barriers is also the current consumer model of owning the goods. In the majority of cultures, ownership identifies a status in a society and presents a strong psychological factor in a lifestyle. In order to reach the change in the system, we need to trigger the mental shift in both the production and consumption sector, as they are interdependent. Increased awareness and clarity on this topic, including the reasons behind, the benefits and challenges are fundamental for the change to happen. (Environmental Indicator Report 2014; Closing the Loop 2015a.)

2.6 Factors and Tools Boosting Circular Economy

Increased general cognizance, the logic behind and assets for the society should be promoted in order to enable the shift in mentality.

Economic instruments, such as green taxes and incentives, pay-as-you-throw (PAYT) pricing tool, Ecodesign and Ecolabel Directives, and extended producer responsibility strategy (EPR) are supportive for the circular economy development (Closing the Loop 2015b). For instance, a sustainable tax policy can support the use of renewable resources. With

sustainable taxation in place, the use of non-renewable resources is taxed and renewable resources appreciably taxed lower or not at all. According to Stahel (2012, 2013), human work should be regarded as a sustainable renewable resource as well. It would be a powerful lever to boost the job creation. (Stahel 2012, 2013.)

Consistent environmental and resource legislations supported by green public procurement (GPP) policies would support innovation and job creation. For instance, a web-based training tool for Greener Public Procurement was prepared by professionals from Finland, Sweden, Norway, Denmark, Germany and others and was launched in 2013. This GPP training tool can be found on www.balticgpp.eu page. This training provides a basic understanding of sustainability of buildings, catering, transport and IT procurement and is available in six languages. (Baltic Gpp 2013.)

Innovation, product design, and co-design are the keys for long-lasting, durable, material-efficient and easily dismantlable products that can be maintained, re-used, re-built or recycled. For this reason, it is necessary to align the position of products, chemicals and waste in legislation to increase the information flow and detection throughout the value chain. (Closing the Loop 2015b.)

The EU instruments that are already in place, such as Ecodesign, EU Energy Label or EU Ecolable, could be combined together with the information regarding the durability and repairability (product passport). Repairability could be increased by repair information and instructions, availability of spare parts and the presence of local repair services. (Closing the Loop 2015b.)

Waste preventing legislation and binding targets for various waste streams would drive investments and break-through innovations. The targets should include every step of the cycle and various waste streams. For successful implementation, unified terminology, standards and definitions should be applied across the EU. Moreover, the waste statistics,

traceability and improved separate waste collection are required. (Closing the Loop 2015b, Roadmap - Circular Economy Strategy 2015.)

To boost the use of secondary raw materials, the quality standards, and reliable online information of stocks and flows of recyclable materials in products, are required. The cooperation through the whole value-chain is crucial. (Closing the Loop 2015b.)

All in all, to be successful, the rules and requirements need to be harmonized and compatible between all member states of the European Union at least, to beat the legal obstacles.

The Environmental Indicator Report (2014) identifies four pillars of the transition from the present production-consumption model; (1) social innovation is defined as a complex of more effective solutions of resource use and addressing the societal needs at the same time, (2) the collaborative and participative consumption of more people sharing the same goods or service, (3) engaging consumers in production processes by prosumerism and smart grids concepts, such as local food or energy generation, and lastly, (4) the technological eco-innovation and ecodesign, aiming for minimizing the products and their production impacts on the environment. (Environmental Indicator Report 2014.)

Also, mechanisms, such as marketing, certification and labeling have significant impacts on recalibration of the consumers' choice and behavior.

2.7 European Commission's 2015 Strategy on Circular Economy

Ellen MacArthur Foundation together with McKinsey & Company consulting firm conducted several reports highlighting the economic reasons and needs for shifting from a linear to a circular economy model. The aim of these reports is to accelerate the transition based on the reports' analyses. The reports are issued annually, starting from 2012, and are available on the Ellen MacArthur Foundation webpage.

The European Commission appreciates the importance and necessity of Europe's transformation into an economy that is competitive and yet resource-efficient. The EU circular economy strategy will be introduced in late 2015. A roadmap, including the introductory strategy description, was published in April 2015 (Roadmap - Circular Economy Strategy 2015). The Commission launched a public consultation on the strategy between 28th May and 20th August 2015 to collect opinions and contributions from public and private sectors on the subject. (European Commission 2015.)

A part of the process was also the stakeholder conference with the fitting title of Closing the Loop - Circular Economy: boosting business, reducing waste, held on June 25th in Brussels by the Commission. The discussions were dedicated to six themes: production phase (1), markets for secondary raw materials (2), consumption phase (3), materials and chemicals (4), research, innovation and investment (5), and waste complement to the legislative proposals (6). The feedback collected will be used in the new strategy. (European Commission 2015.)

The employment growth is at the top of the agenda of the European Union. In Europe, eco-industry employs over four million people. It is assumed that more than 400 000 new jobs will be established by 2020 in the waste sector alone. Additional 200 000 new jobs can be achieved by introducing higher recycling targets. As Commissioner Karmenu Vena (2015) presented on the Closing the Loop conference, the green sector has been resilient and growing even during the economic crisis, as can be seen in Figure 9 below. (Closing the Loop 2015a.)

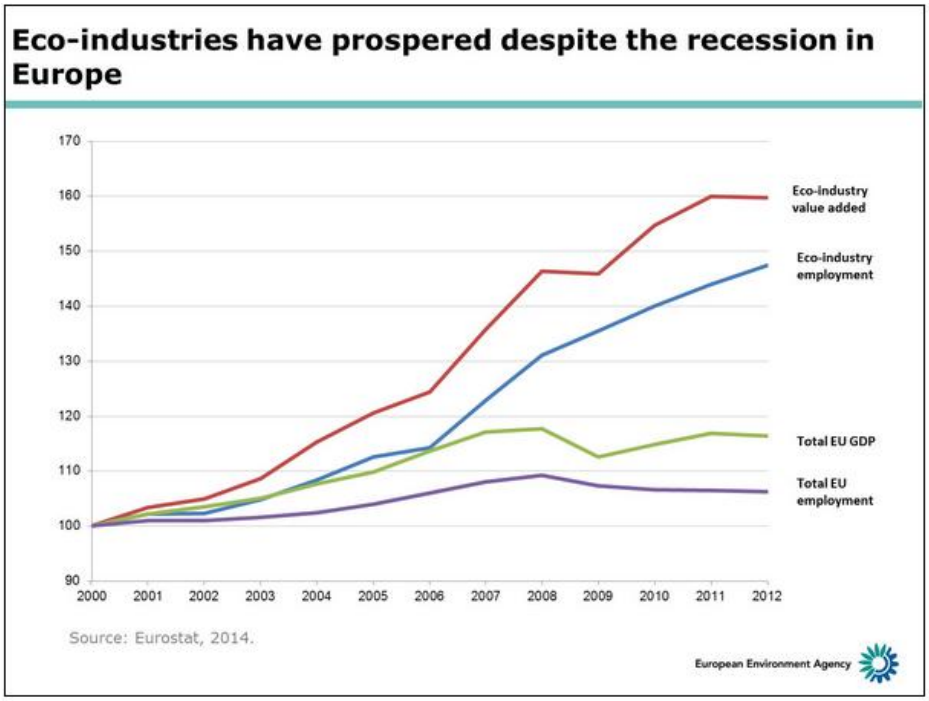

Figure 9. Eco-industries' prosperity despite the recession in Europe (European Environmental Agency 2014).

One of the key messages from the stakeholders' conference was that "There is no one-size-fits-all solution to product design". Therefore, the differences in materials and products within various industrial sectors need to be taken into account. (Closing the Loop 2015a, 2015b.)

2.8 Circular Economy in Finland

According to the Strategic Programme of the Finnish Prime Minister's Office (2015), the Finnish Government's objectives are comprised of sustainable economic growth, creation of new jobs and thus employment increasement, funding of public services and social security. A circular economy, together with bioeconomy and cleantech, is one of the strategic programmes of the Government. It has been understood that a stimulating environment for the circular economy operation is needed, including investments in innovation and new technologies, in both of which Finland is one of the leaders. It has been also acknowledged that both the industry

and the society play a key role in building the new circular business model. (Finland, a land of solutions 2015; Pantsar 2014.)

Since 2000, Finland has scored high in various international competitiveness and innovation comparisons. According to the 2014 Global Cleantech Innovation Index, published together with WWF, Finland ranked second on the overall index, expressing the potential for cleantech entrepreneurial start-ups and commercialisation of clean technologies and innovations over the coming ten years. (Global Cleantech Innovation Index 2014, Tekes 2015.)

Finland has one of the largest cleantech-related R&D budgets. Nearly 50 000 people work in the cleantech cluster with an expectation of 40 000 new job positions established by 2020. These are big numbers given the total population being only over 5.4 million. (Global Cleantech Innovation Index 2014, 16; Statistics Finland 2015.)

Tekes, the Finnish governmental Funding Agency for Innovation promotes and finances research, development and innovation in the country with a focus on projects with long-term benefit potentials for the economy and society. Tekes finances R&D projects i n companies as well as universities and research institutes. (Tekes 2015.)

Sitra is an independent Finnish Innovation Fund operating under the Finnish Parliament. Sitra aims for promoting economic growth, prosperity and sustainable well-being in Finland. Sitra's strategy is to develop new sustainable operational models for society thinking in a new-way. Sitra brings all the players to cooperate together businesses, municipalities and cities, households and public administration. According to a survey conducted by Sitra, a change towards a circular model could bring Finland a growth potential of 1.5 to 2.5 billion Euros. (Sitra 2015.)

Motiva Ltd and its subsidiary Motiva Services Ltd are Finnish state-owned companies, which inform, promote and publicize the material and energy efficiency in communities, businesses and consumers on the national

level. Motiva advances the use of renewable energy and supervises the implementation of the Energy Efficient Agreement and, moreover, affects consumer's choices and habits and provides consultancy and training services. Motiva also contributes to establishing new partnerships, businesses and jobs. (Eskola 2014; Motiva 2015.)

Sitra and Motiva together developed a resource-efficient model contributing towards a circular economy, called FISS (Finnish Industrial Symbiosis System). FISS is based on the good experiences of the British National Industrial Symbiosis Programme (NISP), which was adjusted to the Finnish environment. The Finnish Industrial Symbiosis System functions as a matchmaker, building new business opportunities and partnerships between companies, based on material and energy efficiency, technology and services (Figure 10). FISS aims not only for identifying new businesses, but also for the waste reuse and decreasing the use of natural resources. At a national level, the FISS system is coordinated by Motiva Oy with a cooperation of regional organisers, who help to identifiy new synergy partners and businesses. (FISS 2015b.)

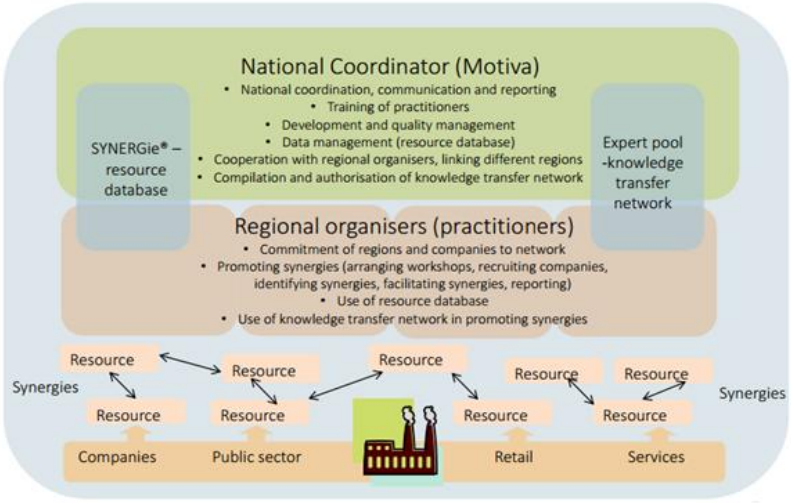

Figure 10. Finnish Industrial Symbiosis System (Eskola 2014).

A common FISS SYNERGie® database provides information about symbiosis in Finland. According to the FISS web page, over 350

companies and 2 042 resources of various types involved in the Finnish Industrial Symbiosis System and can be seen in Figure 11. (FISS 2015b.)

Figure 11. Industrial Symbioses Finland (FISS 2015b).

2.9 Case Studies

In this subchapter, several case studies and examples from markets in Europe, Finland and specifically from the Lahti region will be introduced.

2.9.1 Case Studies - Europe

The Ellen MacArthur Foundation's 2012, 2013, and 2014 Towards the Circular Economy reports provide examples of European companies already applying the concept and principles of the circular economy.

- Kalundborg Symbiosis

The Danish Kalundborg eco-industrial park represents the first well-known industrial production network with a cycling management of resource and material efficiency in the world (Figure 12). It has become a textbook example of an industrial symbiosis. Today, nine companies rely on each other for 30 different material input flows. They exchange their material waste, water, energy, and they also share employees, equipment and

knowledge. This symbiosis has created new businesses, reduces costs, improves resource efficiency and brings many environmental benefits. (Kalundborg Symbiosis 2015a, 2015b.)

The Kalundborg Symbiosis started in 1961 and has continuously developed over the years. In 1989, the phrase ‘industrial symbiosis’ was used for the very first time. (Kalundborg Symbiosis 2015a, 2015b.)

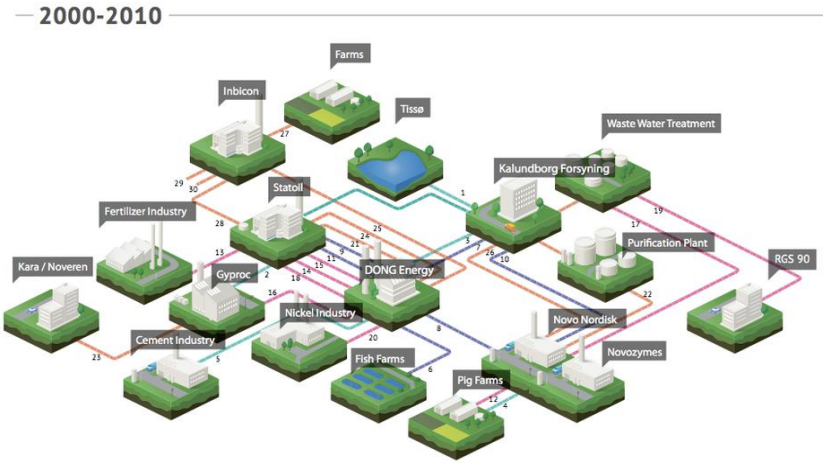

Figure 12. Kalundborg Symbiosis (Kalundborg Symbiosis 2015a).

- Michelin

The tyre industry’s annual consumption is 32 million tons of materials, of which 75% are fossil-based. Throughout the lifecycle, the use of tyres itself accounts for 90% of the overall environmental impact. (The Economic Times 2014.)

Michelin is a leading tyre manufacturer for cars, bikes, airplanes, trucks and other machines. The company activated four principles: reduce, reuse, recycle and renew, for transition to a circular economy. The goal is to reduce the material used in tyres and at the same time, to deliver long-lasting and fuel efficient tyres. To extend the life-cycle and thus increase the efficiency, tyre services must be available. This was one of the reasons for Michelin to offer a tyre lease solution. The tyres could be repaired, regrooved or retreaded and used again. At the same time, raw

materials can be saved. As a last option, tyres can be recycled. In general, tyres are recycled for other purposes than in tyre's production. Inspired by this fact, Michelin launched the Tyre Recycling (TREC) project dealing with end-of-life tyres in 2014. Two processes were developed: the first one, TREC Regeneration, which concentrates on manufacturing regenerated rubber from scrap tyres and use it for new tyres production. The second process, TREC Alcohol, aims for producing ethanol from used tyres, which can be applied for material synthesis. The last principle of renew deals with increased share of renewable raw materials in production. Michelin introduced BioButterfly project for generating butadiene directly from alcohol, which is linked to the TREC Alcohol project. Another project deals with the biomass originated from the isoprene production. (The Economic Times 2014.)

Michelin launched the 'pay-per-kilometre' tyres leasing model in the 1920s. Michelin Fleet Solution management includes the upgrade, maintenance and replacement of tyres. Thanks to this solution, Michelin is able to extend the tyre life (reuse) and at the end, secure the material cascade (recycle, renew). Concurrently, customers benefit from lower overall costs, no stock-keeping needs, and a wide choice of safe and up-to-date tyres. (Towards the Circular Economy Vol. 1 2012.)

- Ricoh

Ricoh is an international imaging and electronics company founded in 1936. The company provides office and IT services and offers 'Software as a Service' (SaaS) document management solution as a part of its Total Green Office Solution (TGOS) programme. Ricoh's aim is to minimize the impact of their products on the environment. As a consequence, Ricoh established the Comet Circle™ sustainable concept in 1994. The Comet Circle™ draws the picture on the overall environmental impact of their products throughout the life-cycle and, in addition, it includes the upstream and downstream activities. The individual comets in Figure 13 represent Ricoh's business partners and the material flow from top right to left and continues from left to right in cycles. The closer to the centre the loop is

the more economic value it maintains. The company offers to customers the lease of office equipment, which will be inspected after the return. Based on the inspection results, products will be renewed and updated with new software. This can be reached only through smart planning while designing the products, so that parts can be easily dismantled and replaced if needed. Then, the product can re-enter the market under the GreenLine label possessing the smart warranty as a brand new device. (Towards the Circular Economy Vol. 1 2012; Ricoh Company Ltd 2015.)

Ricoh set up reduction targets in several areas to be reached by 2020. According to the Sustainability Report (2014), the total lifecycle CO_2 emissions should drop by 30% by 2020 (from 2007 level) and already in 2014 the company reached 37.3%. The new resource input in manufacturing should be reduced by 25% from 2007 values and by 2014 it had already decreased by 19%. All these reductions were achieved while production and sales volumes have expanded. (Ricoh Group Sustainability Report 2014.)

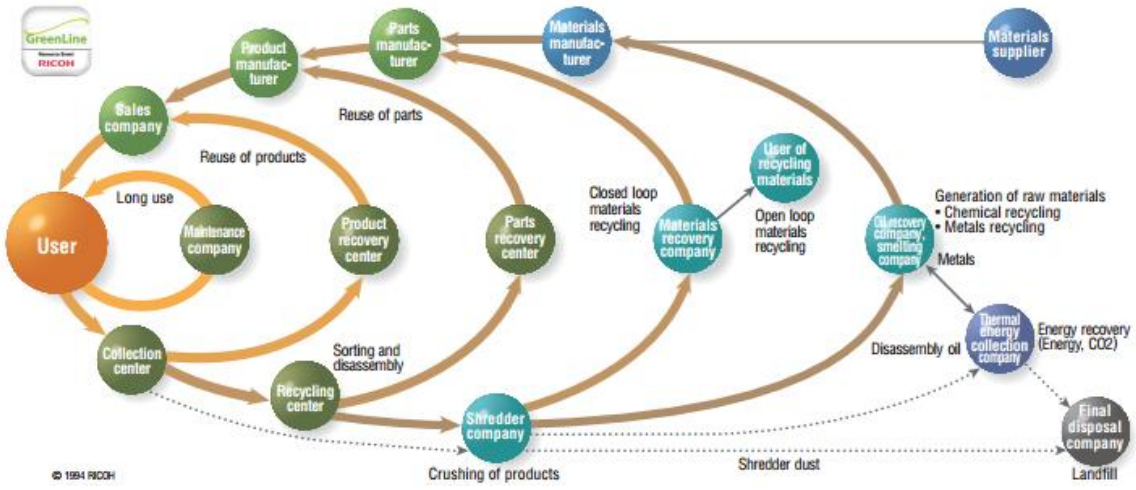

Figure 13. The circular economy at work: Ricoh's Comet Circle™ (Ricoh 2015).

- Phillips 'Pay per lux' Project

Philips is a Dutch company providing innovative lighting, healthcare and consumer lifestyle solutions. (Philips 2015.)

In 2011, architect Thomas Rau demanded light fitting for a new studio from Philips. He did not want to deal with expensive lighting, maintenance and ultimately, the replacement or disposal. Instead Rau requested a certain number of light hours. (Philips & Turntoo 2011.)

The ‘Pay per lux’ project is based on Stahel’s performance economy, when starting selling light as a performance or a service. Everybody benefits from this model. Customers receive and pay only for the service they need and actively use. Often such a service is of better quality and the best solution, as it is in the manufacturer’s interest to produce a long-lasting, eco-efficient and eco-effective product. Manufacturers benefit from secondary material sources, as they remain the owners of the product and by employing eco-design and product planning, they are in charge of the maintenance, repair, reuse and recycling. (Philips & Turntoo 2011.)

Based on that, Philips evaluated the premises to assure they will not provide unnecessary energy or material, taking into account natural light in the building. The building was equipped with energy-efficient LED lights adjusting the light intensity based on the sensors and control system for minimizing the energy consumption. As a result, 55-35% energy reduction was achieved by LED fitting and additional 20% was accomplished thanks to the Philips optimization. Based on this project, Rau established the Turntoo platform, offering solutions and consultancy in product-resource management. Philips continues in lighting service model. (Philips & Turntoo 2011.)

- Mud Jeans

It is estimated that 15 million tons of clothing end up in landfills in Europe and North America. Clothes are purchased on a regular basis due to fashion styles, and change of size or taste. Due to increasing incomes also in emerging markets, the clothing waste is expected to grow if the ‘disposable clothing’ trend persists. (Towards the Circular Economy vol. 2 2013, 53.)

Mud Jeans is a Dutch sustainable clothing company that completely operates according to the circular economy principles. The company was established in 2008 and their unique ‘Lease a Jeans’ leasing system was created in 2013. Customers can lease pair of jeans for €5 a month for one year. The repair service is included in the lease. After one year, customers can change the jeans for new ones and continue the lease for another year or pay additional €5 for four months and wear the jeans as long as they want or just return them back to the producer. (Mud Jeans 2013.)

For the European distribution, Mud jeans are made in Italy, using fair-trade organic cotton or recycled fibres. As Mud Jeans remains the owner of the product, every piece of garment they get back from customers is either re-leased as used or vintage clothes, named after their former user or it can also be repaired or stone washed and the fabric can also be upcycled into another garment, such as shoes or sweatshirts, and ultimately recycled. Everything is done locally to promote the local employment. During recycling the fabric is shredded and mixed with new organic cotton. (Mud Jeans 2013, 2015.)

To produce one pair of jeans, 8 000 litres of water is consumed. Therefore, less water is needed when recycled fabric is used. In combination with a sophisticated filtration system in the denim mill and a wastewater-free system, up to 85-90% of water can be saved. Also, by minimizing the use of chemicals in laundry processes, additionally up to 80% of water can be saved. (Mud Jeans 2015.)

2.9.2 Case Studies - Finland

Five inspiring cases from Finland and their way of approaching the circular economy principles are mentioned below.

- RePack ™

Over 3.7 billion one-time-use-only delivery packages a year are sent to European e-commerce customers. The RePack unique packaging system

enables online-based shops to use sustainable delivery packages that can be re-used after their return back to the retailer. If a customer selects a RePack option, a refundable deposit will be paid. The RePack package can be easily folded into a letter size and mailed with the enclosed address and prepaid postage stamp back to the online shop. After sending the package material back, customers are credited with the deposit and awarded with a discount voucher for their next shopping. The RePack can be used again so it saves costs to the retailer, it decreases the CO_2 emissions four times compared to conventional one-time-use packaging, it offers a sustainable delivery method to the end-user and the enclosed voucher boosts the business even more. (Catalyze Impact 2015; RePack 2015.)

The RePack project started with Finland's Post Office in 2010 and the first customer integrated RePack into the delivery alternatives in 2012. RePack was intended for fashion webstores at first; the company has also been developing solutions for electronics and furniture (such as for Isku company) as well. With regards to furniture packaging, RePack offers shorter packaging time, from 16 minutes down to 2 minutes; it is also easier to carry due to the ergonomical design and unpacking is user-friendlier as well. (RePack 2015.)

RePack has been awarded as a startup company in Berlin (2013), with a design award in Finland (2014) and an innovation prize from the Finnish packaging association (2013). (RePack 2015.)

The size of the packages can be tailore-made. The small packages are made of upcycled billboards. Medium and large packages are made of light and durable polypropylene, which can be 100% recycled at the end of the life-cycle. RePack can be reused up to 50 times. (RePack 2015.)

- Kemppi

Kemppi is a Finnish welding manufacturer. Kemppi has changed its primarily orientation of a machine manufacturer to a service provider. This transition enables Kemppi to promote resource efficiency. The company

advises customers to choose the appropriate equipment, provides machine maintenance, repair and upgrading services if needed. Kemppi also arranges training for welders and is active in continuous development of its products and services. Being a service provider and manufacturer at the same time gives Kemppi a possibility to extend the machines' life cycle. To intensify the resource efficiency, the Kemppi Arc System software helps to maintain the quality and productivity of welding production. (Catalyze Impact 2015; Kemppi 2015.)

- Martela

Martela is an office interior provider, which helps customers to optimise the use of their premises in an effective way. Martela carefully designs their furniture and follows the new trends of less working stations and more social spaces in offices. Moreover, Martela deals with the furniture waste from offices and offers their customers the possibility of renting furniture instead of buying and owning. At the same time, a functional and supportive working environment is crucial for the well-being of the employees' community. (Catalyze Impact 2015; Martela 2015.)

The Martela Lifecycle® model offers facility management for offices, schools, and other public spaces. It includes the entire property lifecycle – premises, furniture and people. Its benefits are sustainable, environmentally and people-friendly offices with lower operating costs. Martela offers a design of new premises based on the business and employees' needs and types, transformation of the current ones, implementation and maintenance. The warehouse facility is also at customers' disposal for unnecessary furniture. Martela also measures the utilisation rates of meeting rooms and working stations in order to ensure space effectiveness. (Martela 2015.)

Martela also offers second-hand furniture and refurbishes, dismantles and reutilizes some components. Some parts are used as secondary raw materials and at the last step as a source of energy. (Martela 2015.)

- Rudus

Rudus discovered its business orientation in construction and other waste streams. The company manufactures stone-materials by recycling concrete and brick waste from constructions with a recycling rate of 80%. Rudus transforms this waste into ‘green’ Betoroc concrete and other stone materials, to substitute gravel and crushed rock in various earth- and roadworks. Rudus also uses fly ash and bottom ash to improve the performance and quality of the concrete and asphalt. At the same time, the carbon footprint from such a recycled product is decreased, and it saves virgin material and follows the circular economy philosophy of a waste being a valuable resource. (Catalyze Impact 2015; Rudus 2015.)

- UPM

UPM is a pulp, paper and timber company, which has extended their activities in to other areas, such as biorefining and bioenergy. UPM connects bio and forest industry towards circular businesses by paying attention to the side streams and resource efficiency of their products and processes. Today, about 90% of their waste is used in other processes or for creating new products; from biofuels, biocomposites and biofibrils, to biochemicals and CO2-neutral energy. By minimizing the waste and maximizing the reuse and recycling, the lifecycle of the used biomass is extended. Thanks to the innovation, research and development, efficiency in material, energy and water use, UPM secures its sustainable position in the future. (Catalyze Impact 2015; UPM 2015.)

2.9.3 Case Studies – Lahti Region

Local examples of a circular economy model in the Lahti region, including the industrial symbioses and one ongoing project will be described here.

- Kujala Industrial Symbiosis

The Päijät-Häme Waste Disposal Company (PHJ), located in the Kujala Waste Treatment Centre is the core of the industrial symbioses seen in

Figure 14 below. Thanks to a sophisticated sorting at-source system, PHJ enables material or energy recycling, and provides an opportunity for new businesses. PHJ's landfill gas is captured for energy use via the Lahti Energia company and distributed directly from the landfill to PHJ's premises and to a nearby beverage producer, Hartwall. (FISS 2015a, 2015b.)

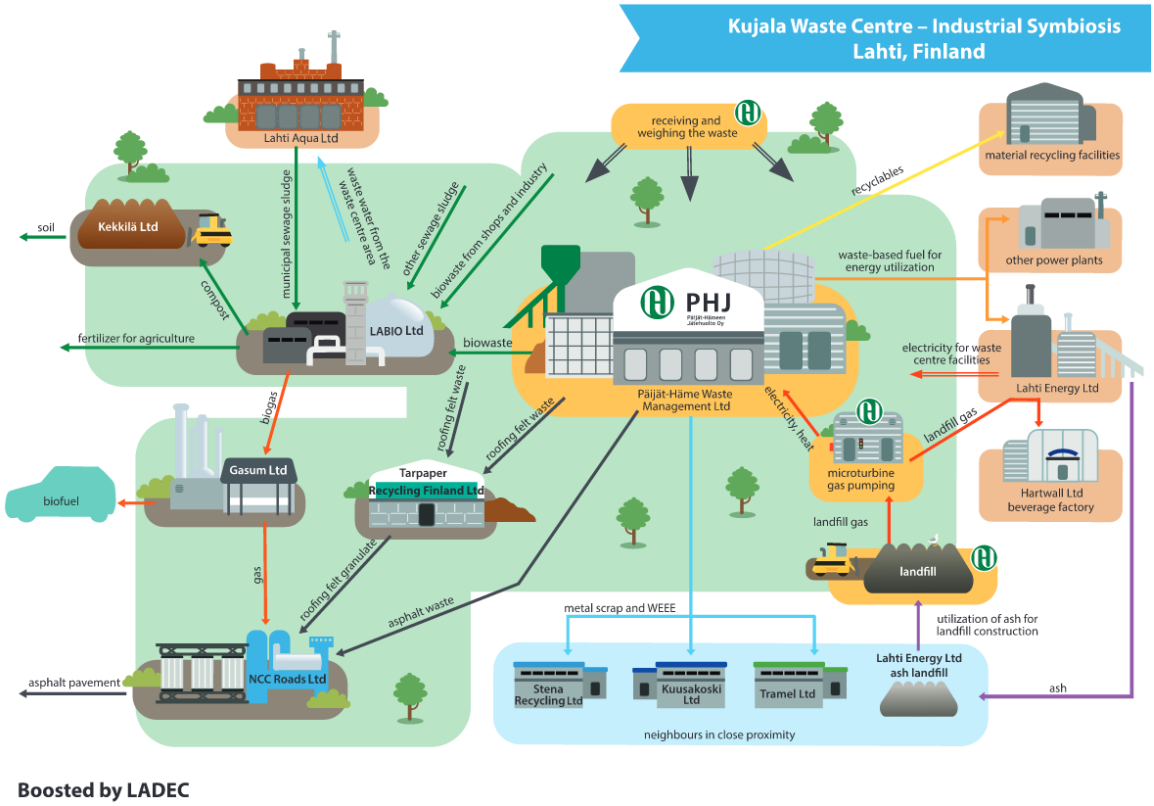

Figure 14. Kujala Industrial Symbiosis (Ladec 2015).

PHJ also collects energy waste, which is processed into a solid recovered fuel consisting of wood waste and household waste, with high plastic content, for the nearby Kymijärvi gasification power plant, operated by Lahti Energy to produce district heat and electricity for the Lahti region. The biological waste and sewage sludge are treated in the biogas and composting facility, Labio. Biogas generated in the dry digesters is then transported through the pipes to the nearby Gasum operator for upgrading and distribution in the gas network. The digestate is then processed with

other biowaste in the composting facility to produce compost and soil, and partially distributed to Kekkilä, where soil and other growing solutions are made. (FISS 2015a, 2015b.)

The metal scrap is separated and forwarded for recycling to service companies Kuusakoski and Stena Recycling. Rudus manufactures earthwork products from the concrete waste. Tarpaper Recycling Finland processes roofing felt waste from constructions, demolitions and sidestreams from producers from the whole of Finland and it is turned into Bitumenmix, which is sold as a secondary raw material to the nearby NCC Roads company for asphalt production. Also, the gypsum plasterboard waste is collected in PHJ and it is sent for new plasterboard production. (FISS 2015a, 2015b.)

- Nurmi

Nurmi is a clothing company located in Lahti. Nurmi has sustainably created long-lasting minimalistic and functional clothes and accessories from ecologically and ethically produced materials, including recycled fibres and upcycled deadstock fabrics since 2010. Nurmi also offers a so called Nurmi Clothing Library, from which one can rent clothes for a certain period and renew the wardrobe without owning the garments. (Nurmi 2011.)

- Reiska project

The Reiska project is a resource efficiency project focusing on new circular economy business models, by enhancing the establishing of industrial symbioses in the Päijät-Häme region. The project is carried out by Lahti University of Applied Sciences and Lappeenranta University of Technology with the support of the European Regional Development Fund in 2015-2017. According to the pre-assessment phase in 2014, about 20% of raw materials are wasted and not used for the final product production. The surplus resources can be turned into direct material and energy benefits, which bring financial and environmental savings. Furthermore, it creates a potential for new businesses. (Autio, Medkova & Cura 2015.)

The Reiska project increases the awareness and understanding of a circular economy in the region, and together with Cursor and Mahdoton network, it also organises matchmaking resource efficiency workshops for companies. The project also offers a motivating educational opportunity for students and companies. (Autio, Medkova & Cura 2015.)

3 EMPIRICAL RESEARCH CONTEXT AND METHODS

In this chapter, the research context and methods applied in this study will be introduced. Also, short summaries of the interviewees will be given.

3.1 Research Context

The research strives to obtain detailed information from experts connected to a circular economy in order to confirm or disprove the theoretical findings. Also, it aims at enriching the findings with the respondents' real-life data and experiences.

Qualitative methods are used when detailed data and as well as the background information are required and when the phenomenon is complex and intricate. On the other hand, the quantitative methods do not enable to elicit details and depth, people's thoughts and perception of the topic in question and do not allow probes. One of the most widely applied methods in qualitative research is an interview. (Blackstone 2012.)

3.2 In-depth Interviews

Qualitative interviews aim for information quality and in-depth insights, hence the name, in-depth interviews (Cleary, Horsfall & Hayter 2014).

An interview is a process of exchanging information on a specific topic between the interviewer, the one posing the questions, and the interviewee, who responds to them. Listening, observing and making follow-up questions are also essential in the process for distinguishing between what is said, what is meant by the response and also the way how the opinion is expressed. (Kvale 2007.)

Kvale (2007) claims, that an informal discussion produces more relevant data than those provided by a formal conversation. This being said, the author, who acted as an interviewer, decided for a semi-structured individually conducted and informal type of an interview. In a semi-

structured interview, the interviewer acts according to a beforehand prepared guide that consists of themes and several questions. Even though the topics being discussed are the same, each interview is different, depending on the respondents' answers and follow-up questions (Roulston 2010, 15).

In order to receive valuable and thematic data, professionals actively involved in actions towards circular economy were asked for joining the research. In the beginning, three to four respondents were expected to be interviewed. In the end, altogether six out of the six experts asked agreed to be part of the research. These experts are from various fields, from governmental and public sector employees to a local service provider and a researcher. The interviewees are briefly introduced in Chapter 3.3.

Based on the literature review, the interview themes and questions were carefully designed to answer the research questions and to be consistent with the underlying assumptions of the theoretical review. During the interviews, the majority of the questions used were open-ended, followed by probes, if answers were not clear or were incomplete. Only a few closed-type questions were posed. On top of that, three multiple-choice questions were composed by the interviewer and were presented in the paper form to the respondents. First, the interviewees were asked for their own opinion and after that they were requested to select three most important choices out of the presented list. (Appendix 1)

Due to the time constraints one of the respondents, one interview was conducted in the form of a detailed questionnaire and is available in Appendix 2. In this case, one of the questions was not clear to the respondent and some missing choice selections were noticed, so further details were communicated by email. Also, in two cases, the three multiple-choice questions were sent to the respondents electronically due to time limitation during the interview.

To meet the aim of this thesis, all six interviews were carried out during September 2015. The interview schedule is seen in Table 1. The

communication of the interviews was in English. To ensure high productivity, the time, approximate duration and a convenient place were agreed to with all the interviewees in advance. In nearly all cases, the one-to-one interviews were organised in the interviewee's premises. The duration of the interviews was between one and two hours and all were recorded.

Table 1. Interviews and Questionnaire Schedule.

	Respondent	Company	Position	Name
Interview	A	Lahti Region Environmental Services	Development Manager Environmental Policy & Climate	Saara Vauramo
	B	Ladec	Head of Account Management, Renewable industry, Environmental technology	Esa Ekholm
	C	PHJ	Managing Director	Tuula Honkanen
	D	D-mat	Member of the Factor 10 Innovation Network Consultant in Wuppertal Institute for Climate, Environment and Energy	Michael Lettenmeier
	E	Motiva	Senior Expert - Resource Efficient Business	Paula Eskola
Questionnaire	F	Cursor	Project Manager	Eija Hämäläinen

Due to the time constraints, the interviews were not transcribed, but digital audio recordings were used instead. All the recordings will be digitally stored in a virtual cloud for 5 years. After each interview, meaning condensation analyses were applied by shortly rewriting the respondent's statements, completed with important quotations and key points.

After that, the analyses were condensed and categorised based on similar patterns, and numbered according to the related questions or themes. The key points were highlighted for easier analysis. Some of the results were expressed in tables or simply described with words.

3.3 Interviewees

Short background introductions of the individual respondents will be presented, including the information of the company they work for and their positions. The reason for these introductions is to show their involvement in the circular economy transition process.

- Saara Vauramo

Saara Vauramo works as a Development Manager for the Lahti Region Environmental Services of the City of Lahti and she is the Head of Environmental Policy & Climate.

- Esa Ekholm

Esa Ekholm acts as a Head of Account Management, Renewable Industry and Environmental Technology in LADEC. LADEC stands for Lahti Region Development and focuses on business development in the region. LADEC is the Finnish Cleantech Cluster leader and focuses on environmental technology, industrial design and innovation.

- Tuula Honkanen

Tuula Honkanen works as the Managing Director of the Päijät-Häme Waste Disposal Company (PHJ), involved in the industrial symbioses in Kujala Waste centre described in Chapter 2.9.3.

- Michael Lettenmeier

Michael Lettenmeier is a consultant in Wuppertal Institute for Climate, Environment and Energy. He has been involved in resource efficiency, material footprint calculation, sustainable consumption and other related projects. He is also a director of a D-mat company focusing on sustainability assessment and development of companies, households or municipalities using a material footprint tool.

- Paula Eskola

Paula Eskola is a Senior Expert in the field of Operating Models and Resource Efficient Business in Motiva. She has been involved in tasks promoting the material and energy efficiency and circular economy in Finland. Motiva is the FISS national coordinator.

- Eija Hämäläinen

Eija Hämäläinen has been working as an Industrial Symbiosis Project Manager in Cursor. Cursor is a regional development company in the Kotka-Hamina region producing business and development services. Cursor also acts as a FISS regional organiser and is involved in promoting the resource efficiency.

4 EMPIRICAL RESEARCH RESULTS AND ANALYSIS

In this chapter, the empirical results from the interviews will be presented and analysed. After that, the outcomes will be cross-analysed against the theoretical findings.

Valuable and enriching information and insights were obtained through the research interviews.

4.1 Circular Economy Concept

At the beginning of the interview, the respondents were asked what a circular economy means for them. A circular economy is an economy in which the resources are used as long and as efficiently as possible in order to save the natural resources. “It is a way the economy can grow and bring new business potential”, according to Vauramo, it requires a dramatic mental shift in the society, which could be one of the most challenging aspects of the change.

The majority of the respondents considered the principles to be based on resource circularity in the biological or material loops. Lettenmeier opposed, stating that these circles have been overestimated and the circular economy cannot work in circles.

Many understand a circular economy as a wide concept and agreed that it might cause confusion between people. No unified definitions and terms are used, and as Lettenmeier stated, “we have a continuous need of inventing new terms rather for the same thing”, which mystifies people. The majority of the respondents agreed that many people have not heard of the term circular economy and if they have, it is a synonym for a better recycling.

Even though the circular economy discussions have intensified lately and the principles have been incorporated in the governmental programmes, the interviewees agreed that the circular economy has not been promoted

enough among the general public. One of the respondents stated the very opposite at first. However, later she realized that it might be caused by her professional blindness as she is constantly involved in the process as well as the people around her.

Only a few interviewees emphasised the importance of the designers and their impact on the product's life-cycle and later its flow and duration in the system. Most of the respondents talked about resource efficiency, which has an enormous economic and environmental impact. However, it is just one of the principles of a circular economy. Only a few respondents mentioned the magnitude of reuse, remanufacturing, upcycling or upgrading. As Tuula Honkanen from PHJ said, "it is too late, the material comes here as waste", and, therefore, they are involved in the material and energy recycling loop. She stated that PHJ will continue to increase the recycling rate and prefer material recycling over energy utilisation.

The attitude towards the circular economy of the companies, represented by the respondents, is very positive. The model is one of their key subjects and the goal is to further develop it.

4.2 Benefits and Disadvantages, Limitations

The benefits of circular economy were easy to name by all respondents However, the disadvantages were not as easy. The interviewees considered that overall dramatic changes are needed and cannot be accomplished in a short time; also that every change brings natural resistance and the beginning both in the consumer and the producer sector will not be easy. Naturally, some of the companies will no longer exist as a result of the change, however, the system offers new business opportunities. One of the respondents assumed that one of the drawbacks could be that people would concentrate on the waste and recycling level only, due to the supposed starry-eyed 100% circularity.

When discussing on the limitations of the model, the vast majority agreed the limits are in our heads, in people's minds; also the current system and

available technologies restrain the transition. Legislation plays a role too, as the current legislation is built for the linear system, in line with the theoretical findings.

During the interviews, the respondents were asked whether the labour should be regarded as a renewable resource as proposed by Walter Stahel (2012, 2013) and thus should be part of the green tax policy. From the respondents, three agreed, two people found it not helpful and one abstained from voting but agreed that this could speed up the job growth.

4.3 Drivers

The interviewees were asked about their opinions on the biggest drivers of the circular economy. Out of the four respondents who answered this question, three referred to the prices and scarcity of natural resources. Additionally, the potential for new businesses, the support and EU legislation and environmental needs were mentioned. Afterwards, the respondents were given a list of drivers, based mainly on the Ellen MacArthur Foundation and other literature sources mentioned in this work. They were asked to select the three most important drivers. The results are balanced and can be seen in Table 2.

Table 2. Circular Economy Drivers.

DRIVERS	Saara Vauramo	Esa Ekholm	Tuula Honkanen	Michael Lettenmeier	Paula Eskola	Eija Hämäläinen	
a. Scarcity of natural resources → volatile prices and accessibility	x		x	x	x		**4**
f. New technologies → better material information and traceability	x	x			x	x	**4**
d. Shift of consumers' behaviour → from ownership to service oriented	x	x				x	**3**
h. Boom of sustainability legislation and regulations		x	x			x	**3**
g. Longer-term investments for companies in material price and risk sustainability → to secure their competitiveness and existence			x	x			**2**
b. Increasing demand → population growth & consumer buying power increase				x			**1**
c. Desire for domestic employment					x		**1**
e. Socio-demographic shift → urbanisation growth, collection costs reduction							**0**

Among the most powerful drivers are: (1a) the scarcity of natural resources causing growing and volatile prices and (1b) the new technologies enabling better information and traceability of materials and thus their utilisation.

Also in the second position, two drivers scored the same number of votes; (2a) the mental shift in consumers' behaviour and the transition from the ownership of goods towards services, sharing and renting and (2b) the new legislation boom promoting sustainability and a circular economy. In the third position (3), are the companies' long-term involvement and investments in developing new services, technologies and a new ways of doing businesses in order to secure their competitiveness.

4.4 Challenges and Obstacles

An interesting discussion arose about what the challenges and obstacles of the implementation of circular economy are. First, the respondents could present their own ideas. The change in people's attitude and thinking is the biggest challenge, as "it is easier to run the business the usual way". Also, the lack of finance and legislation support can be seen as change decelerators. Sometimes, the drivers can act as obstacles at the same time.

Next, the list of challenges and obstacles was presented and the interviewees were asked to again select the three biggest challenges and also what the solutions to those challenges could be. All participants agreed unanimously that the biggest challenge is to (1) assure the attractiveness and competitiveness of the secondary raw materials, both from the financial and the quality points of view. The respondents see the solution in developing new quality standards, criteria and secondary markets management. One of the respondents stated that "the quality control today is more strict to secondary materials than to primary materials, such as soil". Also, it is crucial to support R&D, education and innovation to invent better technological solutions. The re-use or re-

produce actions need to be heavily promoted to be widely accepted, as a recycled material might have slightly negative image in comparison with the virgin materials. To make the secondary materials profitable, prices should be influenced by politics and green taxation policy should be applied. One of the respondents proposed ‘a material added tax’, that would go through the system up to the end-user.

Also, targets not only for recycling but mostly for repair, reuse and remanufacture should be presented. When asking the respondents whether the targets should be binding or not, the responses were balanced.

In terms of the binding versus non-binding targets, in general, based on the discussions in the European Union, the compulsory targets are of a preference. It is supported by similar binding targets already in use, such as the ban of biological waste on landfills. If those targets were on a voluntary basis, not many results would be seen. On the other hand, the Finnish experts interviewed are inclined to prefer non-binding targets. As a compromise, non-binding EU targets were proposed with a voluntary agreement on a national level.

The current (2) consumer model of owning goods was placed in the second position and was selected by five out of six respondents. According to Hämäläinen, the ownership of goods also represents a cultural issue. New ways of thinking and especially smart planning enables us to use the same resources many times, such as a car-renting pool. Others recommended the small-scale pilot projects to be supported for testing the new service-oriented systems to learn about the positive and negative sides before applying those in a large scale. As Ekholm stated, “Good examples are needed!”. Vauramo introduced the example of a Smart Retro project dealing with potential services replacing the owning model in smart cities. The project took place during May 2014 and October 2015 and was funded by Nordic Innovation. She also emphasized that the positive feedback of the project and discussions in the media make the

decisions easier for the followers. The respondents also stressed the importance of the general awareness and innovation needed to develop concepts convenient enough for the consumers to make the change happen. Ekholm also proposed new financing instruments especially in terms of joint owning.

Disharmony in the legislation (3) between the states was selected by four out of six respondents. They believe the legislation should be replaced by new circular economy friendly legislation, based on collaboration and communication of all the players. According to Vauramo, “New circular economy targets (from EU) do not help if the national legislation inhibits the use of ‘waste’ as a resource.” Waste is already seen as a valuable resource but the legislation restrains the status of a material, and, for instance, the REACH was mentioned by Ekholm. The status of a waste versus a secondary material or a product is seen as an issue as well. The end-of-waste criteria under the EU Waste Framework Directive should be reviewed.

Table 3. Circular Economy Challenges and Obstacles.

CHALLENGES/OBSTACLES	Saara Vauramo	Esa Ekholm	Tuula Honkanen	Michael Lettenmeier	Paula Eskola	Eija Hämäläinen	
a. How to assure the secondary raw materials costs to be lower and the quality to be better or at the same level as the primary resources – no technology available	x	x	x	x	x	x	6
e. Consumer model of owning the goods – also a cultural issue	x	x		x	x	x	5
b. Disharmonized legislation, the status of waste/product	x	x	x			x	4
c. Targets, reliable information and quality standards missing				x	x		2
d. Supply-demand secondary market management			x				1

All results are depicted in Table 3 above. However, it was discussed that all the options affect the implementation of a circular economy.

4.5 Factors and Tools

Also, the factors or tools contributing to an implementation of a circular economy were discussed. The respondents indicated that financial support, motivation, and development of new business models are significant. Subsequently, the interviewees were given a list of factors and tools, out of which three most important options should be selected. The results can be seen in Table 4 below.

Table 4. Circular Economy Factors and Tools.

FACTORS & TOOLS	Saara Vauramo	Esa Ekholm	Tuula Honkanen	Michael Lettenmeier	Paula Eskola	Eija Hämäläinen	
a. Economic instruments → such as: green tax policy, incentives, pay-as-you-throw (PAYT) pricing tool, ecodesign, ecolabel, extended producer responsibility strategy (EPR),…	x	x	x	x	x	x	**6**
h. Innovation, product design, co-design → long-lasting durable material efficient and easily dismantle products that can be re-used, re-built or recycled → Cooperation & Info sharing	x	x	x		x	x	**5**
d. Financial instruments + funds → such as Horizon 2020		x				x	**2**
g. Mental shift → Increase awareness and clarity on this topic				x	x		**2**
i. Repair information and instructions, availability of spare parts and a local repair services presence	x			x			**2**
e. Set up also targets for repair and refurbishment or recycle content requirements in products in the whole chain not only recycling targets.			x				**1**
b. Harmonized environmental and resource legislations (green public procurement -GPP) → would support innovation and job creation							**0**
c. Unified terminology, standards and definitions							**0**
f. Less administrative burden							**0**
j. Waste statistics, traceability and improved separate waste collection required							**0**
k. Material banks → to boost the secondary material use (stocks and flows)							**0**

All the respondents voted for the economic instruments to be the most important one. It consists, for instance, of green tax policy, various incentives, PAYT pricing tool, Ecodesign and Ecolabel Directives, EPR strategy, etc. Lettenmeier proposed ‘a progressive tax of resources’ in addition to the material added tax mentioned before. He explained the principle with an example of a fuel or electricity consumption. Up to a certain amount of litres of fuel or kW of electricity the price would be rather low but after exceeding this limit, the price would progressively grow,

which would encourage for decreasing the consumption. Similarly, Ekholm proposed a high tax for short-lasting goods.

In the second position the innovation, product design and co-design were selected by five out of six respondents. This is essential for creating long-lasting products that could be easily dismantled, reused or rebuilt and lastly recycled. The cooperation and information sharing is essential as in the case of co-design, where the producers involve the consumers in product or service design.

The third position is shared by three factors and tools; (1) the financial instruments, such as Horizon 2020, (2) a mental shift triggered by increased awareness and clarity on what a circular economy is and its benefits, and (3) repair information and instructions, including the availability of spare parts and naturally the existence of local repair services, which would generate more jobs locally. Currently, the repair services and, therefore, the reuse system, are underdeveloped.

4.6 Other Findings

During the interviews, the respondents were asked to comment on the waste-to-energy plants in terms of a circular economy. Their statements included opinions about these plants and their slow disappearance in the future and the speed being influenced by the available technology for utilisation other than incineration. However, four respondents agreed that well-designed waste-to-energy systems will still be needed for some time, as “materials have their end-of-life too”. Nevertheless, this can be true until a better solution is found. In general, if the principles of the circular economy were applied and the waste prevention was urged, the amount of waste for incineration would naturally drop greatly.

The interviewees were also asked how easy they think the shift in people’s attitudes and minds, in terms of a circular economy, would be in Finland. The comments were similar, stating that it will take time; however, examples are already visible. As stated by Hämäläinen “Circular economy

is everywhere and every day!" The success depends on raising the awareness of the general public and promoting the benefits and reasons behind the needed change towards a circular economy. They agreed that the change might be easier for the younger generation. Vauramo believes that already enough mental power exists among individuals who can affect the system. She also mentioned that "circular super-hero stories" can be found from the times when Finland was a poor country and being sparing with resources of any kind was a must. She stated, "Is there any way that we could still learn something from our own background?"

As an example of reuse, flea markets were mentioned, which are very common in Finland. Lettenmeier, however, commented that the flea markets also encourage people to buy new stuff and throw away the one they do not have a use for. He feels confident about the needed change as he supposes people are willing to change. Hämäläinen quoted "current 'wear and throw away' quality sets pressure to the opposite" as products are not made to last long.

The respondents were also challenged with the relationship between the terms of a circular economy and a green economy. The responses were that the terms mean the same, or that the circular economy represents the bigger picture and the green economy is a part of it. Some think the green economy is related to a sustainable natural production in the environment promoting renewable resources and a circular economy rather focuses on materials and the life-cycle. For one of the respondents, the circular economy has a notion related to waste and a green economy is a more abstract and less biased term.

When comparing the findings coming from the literature review against the outcomes from the interviews, the majority of the respondents' views correspond with those of other countries of the European Union.

4.7 Action Taken and Future Plans

- Lahti Region Environmental Services

The city of Lahti is going to be a bigger municipality starting at the beginning of 2016 when a neighbouring municipality, Nastola, will join Lahti. As Vauramo said, this could be a momentum for implementing the circular economy and its promotion into the city's strategy.

The city of Lahti has set ambitious targets and organised several campaigns promoting a sustainable and resource efficient city. For instance, the CO_2 reduction targets were announced and the aim for decreasing the CO_2 emissions by 50% from the 1990 level by 2025.

Lahti city is also one of the 16 National Earth Hour Capitals of 2015 in a year-long competition among cities, The Earth Hour City Challenge, organised by WWF. The challenge aims at renewable energy promotion and preparation for climate change. The participating cities strive for a transition towards 100% renewable energy, air and water quality improvement, as well as urban flooding reduction.

Another example Vauramo mentioned, is a 10-year-long ESCO (Energy Service Concept) project together with Siemens, which started in 2014. It endeavours to save energy by 30%. Lahti has a goal to cut the energy consumption by 15% from the 2006 level by 2015. The contract value is three million Euros in total. Vauramo explained that the city owns around 300 properties in the city, such as schools and kindergartens, theatre, library, sports arena, the city hall, to name a few. She explained that Siemens makes the investments based on energy audits and the costs are paid back by the money the city saves due to the energy efficiency arrangements.

During the Lahti Science Day 10 November 2015, a new 'One ton less' campaign will be introduced. City of Lahti together with, D-Mat Ltd, Lahti University of applied Sciences (LUAS), Päijät-Häme Waste Disposal Company (PHJ) and Technical University of Lappeenranta will start a

campaign to reduce the material consumption rate and encourage a resource efficient way of living. The campaign aims at reducing the citizens' material footprint by one tonne every year. Material footprint is a tool calculating the whole product life-cycle and its overall resource consumption, including all ingredients as well as the production processes along the whole value chain. According to a study by Lettenmeier et al. (2014), 40 tons of materials are consumed every year by an average person in Finland. However, the sustainable consumption is regarded to be not more than eight tons per person a year. So, the sustainable level would be reached in 32 years if one ton a year less material was used. (Lettenmeier et al. 2014; Lahti 2015)

Vauramo also confirmed that the green public procurement is a key and has been heavily applied, as the budget of this rather small city (130 thousand inhabitants) is over 100 million Euros. A special organisation is dedicated for purchasing sustainable services and goods based on environmental criteria. These criteria need to be developed and extended to other areas of procurement. The city has a significant impact on public opinions and therefore all the steps already taken and also those only coming should be more communicated and promoted. For instance, the overall impact of the energy efficiency project on the Lahti's city hall, the amount of energy, emissions saved should be promoted. The city is also responsible for purchasing the public transportation services. At the moment the providers meet the highest CO_2 and small particle emission (EUROa6) requirements. In the future, they will consider a biofuel or electric bus fleet.

- Ladec

There are many projects Ladec is involved in or plans for the future. Ekholm mentioned, for instance, the resource efficiency promotion and development, such as the Kujala symbiosis or developing nutrients circulation from sludge in the Helsinki region. He also introduced a Tekes-funded project concerning the energy symbiosis in Lahti. This project is in

a pre-assessment mode and aims at utilizing the heat excess from companies.

- PHJ

PHJ endeavours to increase the recycling rate of the handled waste and favour material recycling over energy utilisation. For that reason, the company invests in a new separation plant, which should be installed in Kujala within a year. This advanced machine is the second of this kind in Finland, and the biggest. Honkanen explained that the new unit will separate the current ‘energy waste’, from which valuable material will be collected for material recycling. Furthermore, from the present ‘mixed waste’, the waste suitable for energy utilisation will be removed as energy fuel in a local gasification plant.

PHJ is also actively involved in the Kujala symbiosis as described in Chapter 2.9.3.

- D-mat

One of the wishes of Lettenmeier is to increase the use and promotion of the circular economy, since he has “the perfect indicator”, meaning the material footprint. D-mat is also involved in the ‘One ton less campaign’.

- Motiva

Motiva is going to continue the material and energy efficiency promotion and implementation, develop the FISS system and together with the regional organisers, organise seminars and workshops on this topic. Motiva would like to promote the circular economy in different ways. According to Eskola, “everything starts with the designers”, therefore Motiva is also involved in an EU Ecodesign pilot project Tuoreverkosto. This project aims at building a network of companies and expert organisations and open communication and development ideas, and collecting and presenting them to the EU.

- Cursor

Cursor continues developing the Industrial Symbiosis program FISS and also the BioA® concept, which focuses on the symbiosis between pulp and paper mills and integrates biorefineries for biogas and/or bioethanol and natural fertilizers.

According to Hämäläinen, the company has connected over 200 companies in their FISS programme. They have held several FISS-workshops and have also given interviews and arranged campaigns to promote the circular economy.

5 CONCLUSIONS

In this closing chapter, the author reflects on the importance of spreading and implementing the circular economy and its principles in education. It is followed by discussing the research validity and reliability and proposals for further studies. Subsequently, the research questions are summarized and to finish, recommendations and conclusions are presented.

5.1 Discussion and Reflections

The author has gained a lot of insights and a great amount of practical information from the interviews, which contributed to a better overall understanding of the topic.

In my studies of the environmental technologies, I have been introduced to some of the schools the circular economy consists of. However, the teaching of this up-to-date topic should be intensified and students should be more involved in related challenges and projects, such as the Reiska project or the ‘One ton less’ campaign introduced earlier. Surprisingly, this new economy model has neither been taught in LUAS Faculty of Business Studies nor in any other faculties of the university. The author assumes that education, in general, should reflect changes in a more flexible way. It is the students of today who can most likely solve the challenges of tomorrow.

5.2 Validity and Reliability

The qualitative method, specifically in-depth interviews, was applied in the research, supported by the theoretical framework. It is expected that the literature review findings would be the same if repeated, however, influenced by the selected sources and leaders’ opinions. Vast and diverse literature resources increase the validity and reliability of the research.

Similarly, the interviews can be redone, following the exact questions and themes; nonetheless, the outcomes may differ due to the human factor. The responses may be influenced by both the interviewer's and interviewees' positive or negative frame of mind and other circumstances, such as time pressure. The research validity is good and is enhanced by the respondents' selection; all being experts in their fields.

In order to increase the quality of the research, the author herself discovered that the list of factors and tools (Table 4) could be redesigned and divided into two categories, such as the major and minor factors and tools. Table 4 includes factors and tools with both the global and niche aspects and, therefore, they are incomparable.

5.3 Framing (FQ) and Research Questions (RQ) Summaries

FQ: **What is the concept of a circular economy?**

Circular economy is a restorative industrial economy, in which waste is regarded as a 'food' or a resource for new processes. It aims at maintaining the added value in products as long as it is viable and through closed loop systems and use of renewable energy bringing the economical, environmental and social benefits.

In circular economy the economic growth is decoupled from the resource consumption by promoting the innovation, smart design, cooperation and collaboration. The concept accelerates the job growth and builds prosperity, well-being and safety of the society and the ecosystems.

The concept is built on rather simple principles, however, it has a huge impact on our way of living, thinking and doing business.

RQ1: What are the challenges/obstacles for a circular economy development (a) in the European Union and (b) in Finland?

RQ1a: Based on the literature review, especially the EU reports and discussions, five main challenges were identified in order to find their solutions. These challenges consist of the secondary material markets and how to make the secondary materials to be competitive as to raw materials. Today's linearly oriented legislation and missing quality standards hinder development. The most quoted examples include the status of waste versus a product/material, administrative burden and disharmonized legislation. The current consumer model of owning goods is considered one of the most challenging obstacles to overcome.

RQ1b: Certain similarities in terms of defining the challenges were found between experts in EU and Finland.

In Finland, the barriers are seen in people's mindset and general awareness, which can be linked with the shift from the ownership model towards services and sharing economy. Also, the missing financial and legislation support corresponds with those factors found in the literature review.

EU experts stated five main obstacles altogether; the challenges related with the secondary materials were selected as the most severe by the respondents, followed by the ownership model and legislation disharmony.

RQ2: What are the circular economy drivers?

One of the biggest drivers is the scarcity of natural resources, which are getting more and more expensive due to their dwindling accessibility; that goes hand in hand with constantly increasing resource demand of the growing population. Simultaneously, the need for boosting new businesses and thus more job creation, with the stress on local employment are equally important drivers. Also, the support and legislation

can drive the change. The shift in consumers' behaviour and expectations can represent both a driver and a challenge. There are people already asking for new kinds of services, rather than simple product purchasing. At the same time, there are people who would resist changing their habits.

Similarly, the respondents' own choices of drivers included the scarcity of natural resources and their volatile prices, the potencial for creating new businesses and the EU legislation and support of different kinds. On top, the environmental needs were proposed as one of the key drivers.

RQ3: What are the enablers of a circular economy implementation?

The awareness and understanding of the basic principles are vital for the mental shift towards the circular economy and are the key stones of the successful realization. There are other stepping stones allowing and supporting the implementation; economic and financial instruments, redesigned legislation fitting the circularity but also the success stories and examples, to name few. Financial support for R&D, innovation and new technological solutions are imperative for the systemic change. This change is dependent on knowledge transfer, cooperation and collaboration. Furthermore, smart sustainable product design and codesign are the starting points of the loops' circularity and should be emphasized.

According to the respondents, the financial support and motivation, as well as the development of new business models enables the change towards a circular economy.

5.4 Further Study

The author suggests that the circular economy awareness and experience from the consumer and producer point of view should be further explored.

A hypothesis of a zero-waste in nature, which is inspiring for society within the circular economy model, ought to be researched from the fossil fuels

points of view. What is the purpose of fossil fuel? Do fossil fuels represent the only nature's waste or is it just something we are not yet aware of? This thought occurred during the discussions with one of the respondents.

Also, the position of a blue economy against a circular economy is worth examination. Does the concept of a blue economy belong under the circular economy, as classified by Ellen MacArthur Foundation, or does the blue economy go beyond it, as stated by Gunter Pauli?

Another area worth examining is whether economy can grow eternally and whether we need the continuous economic growth. Is there another measure of country's prosperity than the economic growth?

5.5 Conclusions and Recommendations

A circular economy is an economic model in which environmental pressures and wastes are minimised to as close to zero as feasible and the added value in products is kept for as long as viable. This is only possible with social innovation, technological breakthroughs due to the currently limiting solutions, and the system level redesign.

Whilst a circular economy offers immense opportunities and though the principles are deceptively simple, the implications on our way of living and consuming, and also thinking and doing business are huge. Promotion, education, support and knowledge transfer are to spearhead the transition towards the circular economy.

It is essential that the awareness and understanding are increased and promoted at different levels. All the players should be engaged in the process; producers, consumers, municipalities, not only at an academic level but mostly at a general level at schools, organisations, among the general public. Especially the needs and the benefits of the new model should be presented in a comprehensible way, tailoring it to the intended audience. The public education should grow among people of all ages,

from small children in kindergartens to seniors. Also, information and experience sharing and learning from the best available practices are required.

Based on the interviews, the overall feeling about the societal change towards a more circular Finland is positive. Finnish people are used to separating waste, inclined to recycle and reuse, and the country is a technological hub and according to many, a cleantech sector leader. Therefore, innovation, technology, sustainable thinking and caring for the environment are the prerequisites for the transition. Many steps have already been taken. However, many are ahead. By incorporating the circular economy in the Governmental Programme (Hallitusohjelma), the state shows its support and the direction to go. Regional development companies, various funds and foundations enable the spark for innovation, research and development. It is well understood that the new model gives an opportunity to build the new kinds of businesses Finland needs.

A combination of an array of present and future policy instruments and economic tools, together with a number of enabling factors and mechanisms can have a synergy effect on the transition.

On the other hand, the concept has its challenges as well. For instance, the new non-owning consumer model represents a risk of a rebound effect. Consumers would get access to more products and services that were not financially available to them before. Also, the producers' ownership requires heavy prefinancing of goods. The additional services, such as maintenance and repair needs to be organised and also the aquisition and collection of goods back from the users is fundamental.

There must be an immense change in thinking about business models, economy, and products on a lease or sale-and-return basis, leading into providing services rather than goods or the use of products instead of their ownership for consumers. The research confirmed that the majority of the

respondents see the biggest limitation in people's minds. New emerging concepts, networks and services are already in place. These forerunners' cases should be promoted as good examples that motivate others to join and contribute to the mental shift. This Bachelor's Thesis also presents several success stories and hopes to contribute to general enlightenment.

It is crucial to establish well-functioning secondary raw material markets with the support of green taxation policy as well targets for producers and manufacturers. It is questionable whether these reuse, repair and recycle targets should be binding or not. It might be a cultural issue, as in some countries anything binding has a negative overtone and thus the non-binding option might be more stimulating. On the other hand, in some countries, such as in Finland, the voluntary targets are rather a binding responsibility. A possible solution arose from the interviews where non-binding targets are proposed for the EU member states and on the national level an agreement is propounded to meet the targets. The EU legislation should enhance the products' repairability and durability. This brings additional benefits to producers as they can provide maintenance service in addition to the main services. Together with the local repair and spare parts shops this could generate new jobs.

A circular economy is not primarily about recycling or waste management. The research showed that the activities of the respondents are mainly focused on resource efficiency and waste management. What should not be forgotten is the profound shift from waste management to material management and, most of all, waste prevention itself. Resource efficiency can be divided into energy efficiency, which focuses mainly on saving energy of buildings, and material efficiency, which addresses the material surpluses or leftovers, already created during the production stage with no use for the producer. It is fundamental to concentrate on the stage before the product is born, the design phase, which influences the product's life and its overall life-cycle impact and to apply the resource efficiency there as well. The knowledge share, collaboration and cooperation are

especially crucial during the design phase, where designers work side by side with engineers, economists, environmentalist and other professions.

In theory, the model of the nutrients and material cycle introduced by Ellen MacArthur's Foundation (Figure 7) should be rather multi-dimensional, to express not only the economic impacts and benefits but also the environmental and social aspects.

The circular regenerative ground-breaking model cannot be in place overnight. However, we still rather concentrate on the outer loops, such as recycling. If we debate about recycling, it is already late, as we allowed waste to occur. At that moment, we are already losing a great value out of the valuable material; in many cases; we talk about downcycling, not upcycling. Recycling represents only a small fragment of the whole circular system. We approach the resource challenge backwards. Now, the concentration moves towards repair and reuse. This is a step forward, although still approached from backwards.

Instead, the holistic view should be seen and all the loops and aspects should be approached as they are on par of prominency today, due to technology and system limitations. However, the mind should be applied to product design, to the phase when the product life and its impact can be influenced. Product design is the starting point of the resource challenge. Thanks to the smart product design and co-design, the overall life-cycle impact can be influenced and the waste creation prevented.

A part of the success lies in raising public awareness of the circular economy principles, the 'What', but most importantly, the reasons for the change, the 'Why', in order to get people to strive toward the same goal. The support and awareness are essential as they are food for thought for society and can give us the innovative answers to the 'How', to accomplish it.

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APPENDICES

APPENDIX 1. Interview Themes and Questions

- **Circular economy (CE):**
  - General understanding & attitude
  - Pros and cons
  - Company's attitude
  - Awareness and understanding
  - Waste-to-energy
  - Green vs. Circular economy
  - Actions and future plans regarding CE
  - Drivers, challenges and tools/factors
  - Labour as a renewable resource

Closed questions:

What do you think about the circular economy and its principles, benefits, etc, are they discussed and promoted enough among general public, schools, and companies in Finland? Please comment.

Yes

No

What do you think about labor work to be regarded as renewable resource → and therefore should be part of the green tax policy?

Yes, I agree

No, I disagree

Multiple-choice questions:

Please select **3 most important drivers** of the Circular Economy, you can always add a new one or comment on it, if you wish:

a) Scarcity of natural resources → volatile prices and accessibility

b) Increasing demand → population growth & consumer buying power increase
c) Desire for domestic employment
d) Shift of consumers' behaviour → from ownership to service oriented
e) Socio-demographic shift → urbanisation growth, collection costs reduction
f) New technologies → better material information and traceability
g) Longer-term investments for companies in material price and risk sustainability → to secure their competitiveness and existence
h) Boom of sustainability legislation and regulations

Please select **3 most important challenges and obstacles** of the circular economy implementation. And **what should be done** in order to overcome it?

a) How to assure the secondary raw materials costs to be lower and the quality to be better or at the same level as the primary resources – no technology available
b) Disharmonized legislation, the status of waste/product
c) Targets, reliable information and quality standards missing
d) Supply-demand secondary market management
e) Consumer model of owning the goods – also a cultural issue

What could help the circular economy implementation, please select **3 most important tools or factors** or add a new one if you wish

a. Economic instruments → such as: green tax policy, incentives, pay-as-you-throw (PAYT) pricing tool, ecodesign, ecolabel, extended producer responsibility strategy (EPR)
b. Harmonized environmental and resource legislations (green public procurement -GPP) → would support innovation and job creation
c. Unified terminology, standards and definitions
d. Financial instruments + funds → such as Horizon 2020
e. Set up also targets for repair and refurbishment or recycle content requirements in products in the whole chain not only recycling targets.
f. Less administrative burden
g. Mental shift → Increase awareness and clarity on this topic
h. Innovation, product design, co-design → long-lasting durable material efficient and easily dismantle products that can be re-used, re-built or recycled → Cooperation & Info sharing

i. Repair information and instructions, availability of spare parts and a local repair services presence
j. Waste statistics, traceability and improved separate waste collection required
k. Material banks → to boost the secondary material use (stocks and flows)

APPENDIX 2. Detailed Questionnaire

1. Please briefly introduce yourself, what is your job, position,...
2. What is your understanding of the circular economy (CE)? (Generally, in Finland, in Lahti or in Cursor?)
3. Cursor's attitude towards the CE (resource efficiency, industrial ecology, cradle to cradle, sustainability, etc)
4. What are Cursor's future plans regarding CE?
5. What are Cursor's actions already taken regarding CE?
6. Benefits and disadvantages of the circular economy, in your opinion.
7. Please select **3 most important drivers** of the Circular Economy, you can always add a new one or comment on it, if you wish:
    a. Scarcity of natural resources → volatile prices and accessibility
    b. Increasing demand → population growth & consumer buying power increase
    c. Desire for domestic employment
    d. Shift of consumers' behaviour → from ownership to service oriented
    e. Socio-demographic shift → urbanisation growth, collection costs reduction
    f. New technologies → better material information and traceability
    g. Longer-term investments for companies in material price and risk sustainability → to secure their competitiveness and existence
    h. Boom of sustainability legislation and regulations

8. Please select **3 most important challenges and obstacles** of the circular economy implementation. And **what should be done** in order to overcome it?

    a. How to assure the secondary raw materials costs to be lower and the quality to be better or at the same level as the primary resources – no technology available

    Solution:

    b. Disharmonized legislation, the status of waste/product

    Solution:

    c. Targets, reliable information and quality standards missing

    Solution:

    d. Supply-demand secondary market management

    Solution:

    e. Consumer model of owning the goods – also a cultural issue

    Solution:

9. What could help the circular economy implementation, please select **3 most important tools or factors** or add a new one if you wish

    a. Economic instruments → such as: green tax policy, incentives, pay-as-you-throw (PAYT) pricing tool, ecodesign, ecolabel, extended producer responsibility strategy (EPR),…

    b. Harmonized environmental and resource legislations (green public procurement -GPP) → would support innovation and job creation

    c. Unified terminology, standards and definitions

    d. Financial instruments + funds → such as Horizon 2020

    e. Set up also targets for repair and refurbishment or recycle content requirements in products in the whole chain not only recycling targets.

    f. Less administrative burden

g. Mental shift → Increase awareness and clarity on this topic

h. Innovation, product design, co-design → long-lasting durable material efficient and easily dismantle products that can be re-used, re-built or recycled → Cooperation & Info sharing

i. Repair information and instructions, availability of spare parts and a local repair services presence

j. Waste statistics, traceability and improved separate waste collection required

k. Material banks → to boost the secondary material use (stocks and flows)

10. How easy do you think it is to make the change in thinking and attitude with regard to the circular model among people in Finland?

11. What do you think about the circular economy and its principles, benefits, etc, are they discussed and promoted enough among general public, schools, and companies in Finland? Please comment.

    a. Yes

    b. No

12. What do you think about labor work to be regarded as renewable resource → and therefore should be part of the green tax policy?

    a. Yes, I agree

    b. No, I disagree

    Comment, if you wish:

13. What would be the impact of the circular economy on existing waste-to-energy waste management systems and the plants?

14. Are there any limitations of the circular model?

15. What is your understanding of a “green economy” vs. a “circular economy”?